SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1925.

GENERAL PHYSICS.

1999. *Method for Measurement of Time Intervals from* 10^{-7} *to* $6{\cdot}7 \times 10^{-11}$ *Second.* **P. Heymans** and **N. H. Frank.** (Phys. Rev. 25. pp. 865–869, June, 1925.)—In this method, when a spark passes across a gap, an electric impulse travels along two nearly identical paths to two electrodes placed in contact with a photographic plate, and Lichtenberg figures are produced on this plate. The shift of the meeting line of the two Lichtenberg figures from the half-way position due to retardation in the path to one electrode is directly compensated by lengthening the electric path of the lead going to the other electrode until the meeting line has returned to the half-way position. Thereby the use of the Pedersen calibration curves is eliminated, the range of the method extended, and the accuracy of the measurements made independent of the variations in the conditions under which the measurements are made. By this method intervals of time which require compensating leads from 30 m. to 2 cm. have been measured—that is, intervals of from 1×10^{-7} to $6{\cdot}7 \times 10^{-11}$ second. AUTHORS.

2000. *Improvements in Laboratory Balances.* **W. Block.** (Zeits. Instrumentenk. 45. pp. 165–175, April, 1925.)—This article deals only with balances of the equal-arm beam type. It refers to Strömberg's investigation of the best form of beam [Abstract 1597 (1915)], to Manley's and to Greinacher's studies of the best method of determining the position of rest. The influence of temperature changes and of uneven temperatures in the balance case is discussed. The author emphasises the need for precautions against these effects, and suggests surrounding the beam with a mass of metal (aluminium) hollowed out just sufficiently to permit the necessary movement. A decided improvement is attained by providing a glass partition to shut off the part of the case containing the beam, so that the latter is not exposed when the case is opened during weighing. Several modern forms of beam are illustrated, as well as various arrangements for adjustably fixing the knife-edges at the ends of the beam, for hanging the scale-pans and for manipulating the rider. The degree of accuracy now attainable in weighing is estimated to be about $1 \cdot 10^{-9}$ grammes. Systems of optical magnification of the beam movements are referred to. Other time-saving devices are an auxiliary indicating balance, which shows as soon as a scale-pan is loaded the approximate weight needed to give balance, and a device arranged to load the beam so that the sensitiveness is reduced to one-tenth for preliminary or approximate weighing. Several complete balances are illustrated and described. The article closes with an account of arrangements for automatic continuously recording balances of the beam type. W. H. G.

2001. *Hardness Tests; the Herbert Pendulum.* **R. Mouillac.** (Rev. de Mét. 22. pp. 223–237, April, 1925.)—This apparatus consists of a heavy ∩-shaped pendulum, carrying a spirit-level and pivoting on a hardened steel, ruby or diamond ball 1 mm. in diameter, which is placed on the underside of the bend of the ∩ and rests on the specimen to be tested. By means of a displaceable weight the centre of gravity of the pendulum is adjusted to a point normally 0·1 mm. below the centre of the ball. A measure of hardness is obtained by swinging the pendulum through a small angle and taking the time in seconds of ten oscillations. Photographs of the impressions left in different metals are given as well as curves showing the relation between the distance from the centre of the ball to the centre of gravity and the time for ten oscillations for different materials. Numerous photomicrographs illustrate the behaviour of glass and various metals under the action of the pendulum. The time of ten oscillations in seconds is found to be approximately equal to the reciprocal of the square of the diameter of the impression produced measured in millimetres. A graph illustrating how the hardness figures found with this apparatus compare with the Brinell figures is given. A second method of using the instrument is to displace the pendulum through a given angle and observe the amplitude of the displacement attained at the end of the first oscillation. It is claimed that the figure so obtained is a truer indication of the resistance of the test material to a tool than that obtained by ordinary hardness tests, since it includes both flow hardness in the original state and also the effect of hardening produced by working ("écrouissage"). Results of tests made on various materials and at various temperatures are given and the interesting fact noted that some steels and non-ferrous alloys which harden when worked at ordinary temperatures lose this property almost entirely over a range of relatively low temperatures, around 100° C. Other tests showed that even hardened tool steel is subject to an effect similar to that of hardening soft metals by working them, and can acquire an additional hardness under such treatment. Still another method of testing is by observing the rate of decay of the oscillations and noting the difference between the logarithms of the amplitudes after one and after 100 oscillations, but the numbers so obtained seem to have no relation with the hardness figures. Illustrations are included of a special support for bringing the pendulum into contact with the specimen and setting it in operation mechanically, and of a large type of pendulum for measurements on work of large dimensions. W. H. G.

2002. *Tests with the Herbert Pendulum.* **L. Guillet** and **J. Galibourg.** (Rev. de Mét. 22. pp. 238–244, April, 1925.)—This article describes a number of tests made with the apparatus described in the preceding Abstract, and gives full details of the precautions found necessary in setting up, adjusting and using the instrument. Results of measurements on steels hardened and tempered in different ways and in a variety of different materials are given and compared with figures obtained by the Brinell test. The authors conclude that the pendulum is an instrument for the laboratory, its use requiring a certain degree of experimental skill. Regarded in this light, it is of service in cases where other tests of hardness fail. Two of the cases dealt with are of especial interest; (1) The investigation of softening produced during the grinding of hardened parts; (2) the investigation of the decarbonisation of high-speed steel during heating prior to hardening. W. H. G.

2003. *Apparatus for the Rapid Measurement of the Surface Tension at the Surface of Separation of Two Liquids. The Influence of Temperature.* **P. L. du Noüy.** (Comptes Rendus, 180. pp. 1579–1580, May 25, 1925.)—The paper describes a modification of the author's "tensiometer" described in 1919 and later [Abstract 2852 (1924)]. The principle of a torsion method is used, the torsion being applied to a platinum annulus 6 or 12 cm. in circumference placed at the surface of separation of the liquids. The point of rupture is obtained by application of torsion. The whole apparatus is light and easily balanced. The temperature effect is measured by heating the liquids under test and maintaining them externally at different temperatures whilst the experiment is carried out. It is shown that for certain liquids—*i.e.* heptaldehyde and certain alcohols—the temperature coefficient is positive instead of the usually accepted result of negative for free air—that is, the surface tension increases with increase of temperature in these cases. S. G. B.

2004. *Viscosity of Reversible Emulsions.* **S. S. Joshi.** (Faraday Soc., Trans. 20. pp. 512–519; Disc., 519–524, April, 1925.)—Viscosities of water-in-oil emulsions prepared from castor oil, olive oil, and paraffin oil by means of four monovalent soaps are determined by means of a viscosimeter of the Ostwald capillary pattern in a thermostat maintained at 35° C. The viscosity increases with increase of the dispersed phase, reaching a maximum at the reversal point and falling suddenly at the inversion stage. The concentration and the specific chemical nature of the emulsifying agent have no effect on the viscosity of the emulsion. The observed viscosities are in approximate agreement with those estimated by Einstein's equation for suspensoids. The Arrhenius equation applies still more closely. The possibility is suggested of an increment in the size of the grains of the water-in-oil emulsions with increase in the proportion of the aqueous phase. A discussion ensues on the applicability of Hatschek's equation for the viscosity of emulsions. J. N. P.

2005. *Contributions to the Theory of Anisotropic Liquids.* **C. W. Oseen.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19a. No. 5. pp. 1–18, 1925. In German.)—In the author's fourth contribution [see Abstract 765 (1925)] he has established to a first approximation valid laws for the propagation of light through an anisotropic liquid. From the fundamental standpoint adopted the author was then able to propose a phenomenonological theory for Friedel's remarkable observations on bodies of the cholesterine type. The present mathematical paper now replaces the above theory by a molecular one. For this purpose new terms are introduced into the above laws which explain the circular polarisation, while the assumption is made that the liquid is magnetically isotropic and that the molecules do not rotate the plane of polarisation. Only a qualitative character is claimed for the results obtained. H. H. Ho.

2006. *On the Flow of Liquids with and without Velocity Potential. Application to the Blades of Turbines.* **Eydoux.** (Comptes Rendus, 180. pp. 1575–1577, May 25, 1925.)—Bauersfeld and Lorentz have shown that for energy exchange between liquid and blade the permanent motion of the liquid in the turbine should be rotational. The present author has also shown that the variation of energy at a point on a uniformly rotating wheel is measured by the volume of the parallelopiped constructed on the three relevant vectors. The present paper discusses this energy exchange, taking account of the existence of the rotational vector in every movement giving rise to it. The reason for free space between distributer and blade which exists in the modern rapid turbine is briefly discussed. The gyratory motion is then treated mathematically, when it is shown that the sections of the current surfaces by a meridian plane are independent of the gyratory constant, and are conserved even when the liquid is directed towards the axis without rotatory motion about it. Reference is made to Prasil's graphical methods. H. H. Ho.

2007. *On the Determination in an Incompressible Liquid of the Velocity Potential Due to a Vortex Tube.* **B. Stetchkine.** (Comptes Rendus, 180. pp. 1577–1578, May 25, 1925.)—A new method of determination is worked out mathematically, using the theorems of Stokes and Dirichlet, the well-known formula, $F_M = I\theta/4\pi$, being derived, where F_M is the potential at a point M, I the circulation along the tube, and θ the relevant solid angle. H. H. Ho.

2008. *On the Motion of Circular Cylinders in a Viscous Fluid.* **R. A. Frazer.** (Roy. Soc., Phil. Trans. 225. pp. 93–130, June 26, 1925.)—This paper is restricted to two-dimensional problems where the fluid is assumed as bounded by circular cylinders. Novel methods are used which have proved useful for more complex boundaries. Of the fourteen paragraphs, the early ones concern functional treatment. An illustration investigates a type of flow maintained between concentric cylinders, including the case where the outer radius increases indefinitely. Here the stream-function determines the conditions of flow due to a stationary cylinder immersed in a uniform infinite stream, and develops the well-known anomalous characteristics associated with such types of motion by Stokes. The main part of the paper deals with systems in which the finite boundaries are defined as a pair of mutually external circular cylinders, an adaptation of Stokes' principle of successive reflections leading to a general expression available for problems in which arbitrary distributions of velocity are prescribed over the cylinders. It is shown that a possible state of steady motion in a fluid at rest at infinity is where any pair of spinning cylinders are rotated appropriately as a "planetary" system about a particular "focus" situated on their line of centres. In illustration of the more general results, a number of simplified problems are treated which include the simpler "planetary systems," and the case in which a cylinder both rotates and translates in the presence of a fixed rigid wall. A calculation of the stress components and forces operating on the latter system shows that the viscous drag and the couple on the cylinder are, respectively, independent of the rotary and the translational motions. In the limiting case in which the cylinder approaches indefinitely close to the wall, both drag and couple tend to infinite values, and a parabolic distribution of velocity develops across the film of contact.

H. H. Ho.

2009. *Resistance to Motion of Small Particles through a Gas.* **J. Mattauch.** (Zeits. f. Physik, 32. 6 and 7. pp. 439–472, 1925.)—Assuming the Cunningham-Stokes formula for the mobility of spheres in gases, measurements are made of the speed of distinct particles of vacuum oil in nitrogen and carbon dioxide at various pressures. The course of Cunningham's correction factor is deduced from the observations, and the value of the electronic charge is calculated as $4 \cdot 758 \times 10^{-10}$ e.s.u. Observations on particles of mercury do not lead to a unique law of resistance. The particles behave as if they belonged to two separate groups, one of which follows the same law of resistance as the oil particles, whilst the other appears to require a much smaller correction factor. [See also Abstract 775 (1925).] G. E. A.

2010. *Windage Losses in Air, Hydrogen and Carbon Dioxide.* **C. W. Rice.** (Gen. El. Rev. 28. pp. 336–341, May, 1925.)—Describes apparatus in which a notched and perforated disk is revolved within a light cylinder floating in an oil-filled trough, the rotation of the cylinder being resisted by a spiral spring. The average air-gap between the edge of the disk and the cylinder is 0·4 cm., and the whole apparatus is contained in a glass bell jar, into which the different gases can be introduced and their pressure varied. Curves are given showing the variation of windage losses with disk velocity for the different gases; it appears from these that the losses are nearly the same in air and in hydrogen when the pressure of the former is reduced so as to make its density equal to that of hydrogen. It is shown that, at each of three different speeds, the ratio between the deflection of the cylinder or drag and the pressure of the air is nearly constant, *i.e.* the windage loss at constant velocity is approximately proportional to the density of the gas with turbulent motion. It is also shown graphically that the frictional force is approximately proportional to the square of the velocity. For CO_2 and air it is also shown that the windage loss is approximately proportional to the density of the gas. The author applies Rayleigh's method of dimensions to the problem, and arrives at the result that for turbulent motion the resistance or force $f = KA\rho v^2$ dynes, where K is a numerical constant to be determined by experiment, A the area of cross-section of the fluid in sq. cm., ρ the density of the fluid, and v the relative velocity between the surfaces; this agrees with the above experimental results. In most rotating machinery the velocities are well above the critical value, and turbulent flow can be assumed. The author proceeds to apply the formula to the case of a large electrical machine. H. N. A.

2011. *On a Method of Measurement of Newton's Coefficient of Restitution and the Law of Oblique Impact.* **H. G. Green.** (Phil. Mag. 50. pp. 187–194, July, 1925.)—An apparatus is described, with four illustrations, by which the coefficient of restitution between a plane and sphere can be obtained to a considerable degree of accuracy. The sphere used was a ball of fairly soft wood, through which a cylindrical hole ran centrally of such radius that it could slide easily on the guiding-rod of the pistol. It was shot obliquely on to a brass plate mounted on an inclined plane, and the angle of the plane was varied until the direction of rebound was as nearly vertical as could be obtained by the means of adjustment, the ball falling back approximately to the point of impact. Means for securing accurate angle measurements are discussed, and both smooth and rough planes are dealt with. The theoretical equations are shown to be very closely satisfied. H. H. Ho.

2012. *On the Motion of a Particle projected from a Point on the Earth's Surface, Variation in Gravity being taken into Account.* **J. Robertson.** (Phil. Mag. 50. pp. 180–187, July, 1925.)—In the ordinary theory of the motion of a projectile the fundamental assumption is that the speed of projection is so small compared with the "speed from infinity" that squares and higher powers of the ratio of these two speeds may be entirely neglected. The object of the present paper is to extend this analysis to the case of great speed of projection, *i.e.* where the height attained is so great that variations in gravity must be taken into account. The results show the path to be really an ellipse, but when the speed of projection is relatively small the part of the ellipse above the earth's surface is not much different from a parabola. H. H. Ho.

2013. *High Speed Rotation.* **E. Henriot** and **E. Huguenard.** (Comptes Rendus, 180. pp. 1389–1392, May 11, 1925.)—The authors obtain very high speeds by avoiding all solid and liquid contact and by turning a conical body with vertical axis within a conical cup by means of jets of compressed air or carbon dioxide issuing from tubes so disposed in the stator as to produce a rising vortex. The cone is truncated near the apex and provided with meridional furrows. When the air is turned on, the rotor is first drawn down into the cup within less than a millimetre of the stator, and then begins to spin. With a rotor of angle 110°, 45 mm. in diameter, and twelve tubes of 2 mm. diameter, fed with air at 2 atmos., a speed of 1300 r.p.s. was obtained. A smaller rotor of 6 mm. gave at 3 atmos. over 11,000 r.p.s. and a constant speed of 4000 r.p.s. was maintained for several hours. Too high air-pressures jerk the rotor out of its cup. H. B.

2014. *Monoclinic Double Sulphates containing Thallium.* **A. E. H. Tutton.** (Roy. Soc., Proc. 108. pp. 240–261, June 2, 1925.)—Tables of interfacial angles are given for thallium nickel sulphate $Tl_2Ni(SO_4)_2 . 6H_2O$, and for thallium cobalt sulphate $Tl_2Co(SO_4)_2 . 6H_2O$, and the interfacial angles, axial angle and axial ratios are compared for the first substance with those of potassium, rubidium, ammonium and cæsium nickel sulphates, and for the second with those of the potassium, rubidium, ammonium and cæsium cobalt sulphates. The optical properties of these different substances are tabulated, including α, β and γ refractive indices, axial ratios of the optical indicatrix, specific and molecular refraction, and dispersion and optic axial angle. The results, and those already communicated for thallium zinc sulphate and selenate, agree in confirming that these double salts are true members of the isomorphous series of monoclinic, hexahydrated, double sulphates and selenates, $R_2M(SO_4)_2 . 6H_2O$; thallium in its thallous capacity is capable of isomorphously replacing the alkali metals and NH_4 in their salts; all the crystals are of the holohedral class (No. 5 in the thirty-two classes of crystals) of the monoclinic system, the maximum difference between the angles being 1·5°, and in most cases the difference is only a few minutes. The angular changes are about the same as when rubidium is substituted for potassium, and much less than when cæsium is substituted; the changes bear no relation, however, to the atomic weight or number of Th as compared with the alkali metals. H. N. A.

2015. *Crystal Structure of the Mercurous Halides.* **R. J. Havighurst.** (Am. J. Sci. 10. pp. 15–28, July, 1925.)—The powder method was employed, the samples being mounted in glass tubes of about 3 mm. internal diameter, and diluted with three to four times their volume of dextrin to decrease absorption of X-rays. Spectra from single crystals of calomel were also obtained by the ionisation spectrometer method; though none of the crystals gave good reflections, they confirm the powder method data. The results are interpreted by means of the theory of space groups, having regard to the intensities of the different lines and orders of spectra and making use of the fact that in the series Hg_2Cl_2, Hg_2Br_2, Hg_2I_2 there is one electronic group (Hg) of constant and another (Hl = halide) of variable scattering power. The true unit cell, the volume of which is half that adopted by previous experimenters, has the following dimensions: Hg_2Cl_2 a 4·47 Å., c 10·89; Hg_2Br_2 a 4·65, c 11·10; Hg_2Br_2 a 4·92, b 11·61. Four molecules of HgHl (two of Hg_2Hl_2) in the unit cell give approximately correct values for the densities. The atoms are arranged in the cell in a peculiar manner, chain-molecules Hl-Hg-Hg-Hl lying along the c axis, the distance between the Hg atoms being less than between the Hg and Hl atoms, which is less than that between the Hl atoms; in the direction at right angles to this the bonds are always between an Hg atom and an Hl atom, though these lie in somewhat different planes. The strong positive double refraction observed is to be expected from crystals having this structure. H. N. A.

2016. *Alterations on the Ductility of Tin Crystals.* **M. Polányi** and **E. Schmid.** (Zeits. f. Physik, 32. 9. pp. 684–712, 1925.)—The cold deformation of crystals [see Abstract 991 (1923)] is bound up with an inner tenacity which for the maintenance of single crystals in the slip surface grows with increasing deformation. This inner tenacity appears even after very slight extensions. Crystal recovery with maintenance of the lattice position leads to a de-solidification effect, which is dependent on the time and temperature of the recovery interval. In consequence of crystal recovery, the period and temperature influence the tenacity effect during the deformation process. Tin crystals afford conspicuous examples of these phenomena. The recrystallisation of cold deformed tin crystals is described in great detail for all kinds of circumstances—extension, rapidly cut, pressed, etc. For ability to recrystallise, the content of internal energy is the important factor rather than the amount of deformation. The paper abounds in experimental detail, data, and illustration. H. H. Ho.

2017. *Theory of the Atom.* **F. Dacos.** (Assoc. Ing. Él. Liége, Bull. 3. pp. 125–152, April, 1925.)—The first of a series of papers intended to give a general presentation of the theory, dealing with the experimental facts and the calculations based on them. H. N. A.

2018. *The Trend of Thought in Physics.* **W. F. G. Swann.** (Science, 61. pp. 425–435, April 24, and pp. 452–460, May 1, 1925. Vice-Presidential Address before Am. Assoc. Adv. Sci., Dec., 1924.)—An interesting survey. The reasonableness of physical hypotheses. The factors which have moulded thought on the lines of classical dynamics. The description of new laws in the language of the old. Definition and scaffolding in physical theory. Conservation of energy in electrodynamics and in experience. The present status of the circuital relations. A possible correlation of classical theory with quantum emission. Stationary states and the laws describing electronic motion. The description of motion in the case of non-linear equations. Conclusions. A. D.

2019. *Theory of the Relation of Spectral Lines to Mass Variations within the Atom.* **L. B. Ham.** (Phys. Rev. 25. pp. 762–767, June, 1925.)—The mass variations of the electrons and nucleus involved in the transitions represented by Bohr's frequency condition, $h\nu = E_b - E_e$ are investigated by use of (1) the mass variation formula of relativity ; (2) the kinetic energy relation of relativity, $\Delta m = \Delta E_k/c^2$; (3) the radiation formula of relativity, $\Delta m = \Delta E/c^2$. The assumption of "potential" and "kinetic" changes of mass lead to concordant results for mass variations in the Bohr theory of radiation and the relativistic theory of radiation. The theory of the hydrogen circular orbit leads to the conclusion that the frequency of spectral lines is a function of the decrease of the mass of the electron ($\nu = \Delta mc/h$), so that the change of mass of the electron may be considered as quantified. The theory is also applied to elliptic orbits, and the fine structure of the hydrogen doublet is explained. The absolute values of the changes of mass of the electron at aphelion and perihelion for various orbital transitions for H_α are given in a table. AUTHOR.

2020. *The Atomic Structure Factor in the Intensity of Reflection of X-Rays in Crystals.* **D. R. Hartree.** (Phil. Mag. 50. pp. 289–306, July, 1925.)—The number "F" for an atom represents the ratio of the amplitude of the wave scattered by the atom to that of the wave scattered by an electron, and depends on the glancing angle and wave-length and also on the dimensions of the atomic orbits and the distribution of the electrons in them. [See Abstract 754 (1924).] Assuming that the individual electrons of the atoms in a crystal scatter classically, the F-curve for any atom, showing the relation between F and the glancing angle, can be calculated from the dimensions of and progress of time in the core orbits by a method the general theory of which is developed by the author, tables being given to facilitate the calculations of the contributions to F from circular and from non-circular orbits. For some atoms the atomic field can be found approximately by numerical analysis of the optical and X-ray spectra, and the core orbits can then be calculated. It is possible to generalise the results and put them in such a form that an approximate F-curve for any atom (or rather ion) can be calculated very simply. H. N. A.

2021. *Circular Orbits in the Hydrogen Atom with Nucleus in Motion.* **E. Reichenbächer.** (Zeits. f. Physik, 32. 11–12. pp. 907–917, 1925.)—The increased frictional drag on an electron due to motion of the atomic nucleus is discussed mathematically, and the question of the impossibility of two or more electrons executing the same orbit is briefly referred to. J. S. G. T.

2022. *The Distribution of the Probabilities of Passages between Quantum Orbits in the Atoms of the Alkali Metals.* **H. Bartels.** (Zeits. f. Physik, 32. 6. pp. 415–438, 1925.)—Fues, in a series of papers, has shown that in many cases it is possible to calculate, from the terms of a spectrum, a central field which gives a good quantitative representation of all the series terms when the emitting electron is considered as moving in this field. The author, using in part the method indicated by Thomas and in part using a new method of approximation has calculated a number of probabilities of passage for sodium, and from these has drawn conclusions as to the dependence of the mean life of the Bohr states on the quantum numbers. The results calculated for sodium can be applied to a certain extent to the other alkali metals. They apply to cases where the initial and final orbits lie mainly outside the atomic trunk, so that during the greater part of the period of revolution they approximate to the elliptical form. This includes a number of observed lines. H. N. A.

2023. *Isotopes of Lead.* **Bertha Perrette.** (Comptes Rendus, 180. pp. 1589–1591, May 25, 1925.)—A *résumé* of the results obtained in the comparative study of lead of radio-active origin and of ordinary lead (from galena) from the point of view of density and of visible spectra.
A. B. W.

2024. *Aberration.* **R. Tomaschek.** (Zeits. f. Physik, 32. 5. pp. 397–402, 1925.)—Aberration does not vary with relative motion of the observer and the source of light. The relativity theory requires that it should do so. Attempts to reconcile the inconsistency. Thirring [Abstract 485 (1925)] and Kopff (Phys. Zeits. 23. p. 255, 1922) are discussed and set aside. A. D.

2025. *Effect of Earth's Rotation on Velocity of Light.* **A. A. Michelson.** (Astrophys. J. 61. pp. 137–139, April, 1925.) **A. A. Michelson, H. G. Gale, F. Pearson.** (*Ibid.* pp. 140–145.)—In Abstract 336 (1905) it was shown that, on the hypothesis of a fixed ether, there will be a difference in path between two interfering pencils, one of which travels in a clockwise and the other in a counter-clockwise direction. If l_1 is the length of path at latitude ϕ_1 and l_2 that at latitude ϕ_2, v_1 and v_2 the corresponding linear velocities of the earth's rotation, and V the velocity of light, the difference in time required for the two pencils to return to the starting-point will be $T = \frac{2l_2v_2}{V^2 - v_2^2} - \frac{2l_1v_1}{V^2 - v_1^2}$. Experiments on Mt. Wilson in 1923, in an open-air circuit, showed results, but these were not measurable. Finally, air was exhausted from a 12-in. pipe-line laid on the surface of the ground in the form of a rectangle 2010 × 1113 ft. Light from a carbon arc was divided at one corner by a thinly-coated mirror into direct and reflected beams, which were reflected round the rectangle by mirrors at the corners. The two beams returning to the original mirror produced interference-fringes. The beam traversing the rectangle in a counter-clockwise direction was retarded. The observed displacement of the fringes was found to be $(0\cdot230 \pm 0\cdot005)$ fringe-breadth, agreeing with the computed value $(0\cdot236 \pm 0\cdot002)$ within the limits of experimental error. [See Abstract 524 (1925).] A. D.

2026. *A Criticism of the Paper of G. Maneff: "Gravitation and the Principle of Action and Reaction."* **K. Popoff.** (Zeits. f. Physik, 32. 5. pp. 403–406, 1925.)—Maneff [Abstract 1572 (1925)] has succeeded in deriving all the results of the relativity theory from the principle of the equality of action and reaction. In the present criticism it is shown that Maneff's results are based upon an incorrect interpretation of the classical propositions. H. H. Ho.

2027. *Electron and Light-quantum from the Experimental Point of View.* **R. A. Millikan.** (Zeits. phys. Chem. 116. pp. 65–80, May, 1925.)—This is a translation of a Nobel Lecture delivered at Stockholm on May 23, 1924. T. H. P.

2028. *The Quantum Conditions.* **G. Wataghin.** (Zeits. f. Physik, 32. 7. pp. 556–562, 1925.)—It is shown that the stationary states of a general class of conditioned periodic systems can be fixed by a single condition, which is equivalent to Sommerfeld's condition of state $I_k = n_k h$ $(k = 1, 2 \ldots \mu)$. A system consisting of particles between which only Coulomb forces act is first considered, and then a more general system, as described by Bohr [Abstract 1315 (1923)]. The paper is mathematical throughout. The single condition mentioned above is written $\overline{E}_{\mathrm{pot.}} = 2W = -\sum_k n_k(h\nu_k)$. The analogous relation for pure periodic orbits is given by Sommerfeld. The above equation is similar to that of the original Planck law $W = nh\nu$ and to Bohr's frequency condition $E_1 - E_2 = h\nu$. H. N. A.

METEOROLOGY AND GEO-PHYSICS.

2029. *Discontinuities in the Atmosphere.* **A. H. R. Goldie.** (Roy. Soc. Edinburgh, Proc. 45. 2. pp. 213–229, 1924–1925.)—The paper contains the results of an investigation, on empirical and dynamical lines, into (1) the origin of surfaces of discontinuity in the atmosphere; (2) the precise processes occurring at such surfaces in well-defined cases; (3) the physical processes which lead to the obliteration or movement of the discontinuities; (4) the part played by the discontinuities in the development of the cyclones of temperate latitudes. A study of individual cases confirms the view that the most important cause of inversions at the surface and in the upper air is a difference of geographical origin and recent past history. Formulæ obtained earlier are extended to the case where the wave movement occurs under approximately adiabatic conditions. The results of the mathematical relations are applied to physical changes existing at the surfaces of discontinuity, and a study of a number of cloud photographs confirms these ideas regarding wave motion. The methods by which the wave motion may be broken up and greater developments result are examined and applied to some cases of squalls. Finally, the effects of rotation of the earth on the wind waves set up are examined and the results applied to examples shown by anemograms for Lerwick. The conditions necessary for the development of a cyclonic circulation from these waves, which at first possessed movement only in the vertical plane, are then laid down. R. S. R.

2030. *On the Mean Variability in Random Series.* **E. W. Woolard.** (Monthly Weather Rev. 53. pp. 107–111, March, 1925.)—A correction is applied to Goutereau's presentation of a statistical index characterising the order of succession of a series of events, and it is extended to include distributions which are not normal. The numerical values obtained were checked and fully confirmed by a practical test. R. S. R.

2031. *Boundary and Drifting Depressions.* **J. Letzmann.** (Meteorolog. Zeits. 42. pp. 181–185, May, 1925.)—A method introduced in an earlier paper [Abstract 1578 (1925)] is developed and applied to several kinds of depressions. By the boundary depressions are indicated those which occur in regions where a boundary zone exists between the polar and equatorial air. Drifting depressions occur less frequently and are those possessing a symmetrical field of flow and three points of zero intensity, one at the centre and two at the boundary. The general conditions required for the production and continuance of a surface of discontinuity are discussed. Finally, a family of depressions is considered and the air movements at different parts in the series for (1) a depression still growing, (2) one fully developed or shortly before this state, (3) another in a state of dissolution. Comparisons are drawn between the properties and origin of the family and the results of the Bjerknes scheme. R. S. R.

2032. *The Change of Wind with Height for Varying Coefficients of Friction.* **W. Milch.** (Meteorolog. Zeits. 42. pp. 188–195, May, 1925.)—The general equations of motion stated by Hesselberg are used to obtain an approximate solution for the changes of wind with height. Two special cases are first considered: (1) Pressure constant in the horizontal plane and the earth at rest; (2) pressure varying in an E.–W. direction only and the earth at rest. The general case involving friction, pressure gradient and the deviating force of the earth's rotation is then taken. The result is obtained that the wind approaches the gradient value in the form of a spiral for the case with a constant coefficient of friction, as found earlier by Exner. No assumptions are made here regarding the changes of the coefficient of friction with height, and the expressions thus hold for all variations. It is shown that the rate of change of direction with height is inversely proportional to the coefficient of friction and to the wind velocity, *i.e.* with stronger winds the change with height is decreased. R. S. R.

2033. *Distribution of Aqueous Phenomena over the Earth.* **G. Hellmann.** (Preuss. Akad. Wiss. Berlin, Ber. 15. pp. 285–298, 1925.)—The author deals with rain, snow, hail, soft hail, ice crystals, glazed frost, dew, hoar-frost and rime, and the distribution as regards latitude and height above sea-level for each. A large number of records have been consulted, and in general all liquid condensation has a polar limit and all solid condensation, except hail, has an equatorial limit. The height limit is an irregular surface, concave to the earth, highest at the equator, and giving at its intersection with the earth's surface the polar limit for the element considered. Rain has a polar limit in the northern hemisphere, probably only over the high ground in Greenland, but in the southern hemisphere the limit occurs near to 75°–77° S. Soft hail is difficult to deal with because distinction is often not drawn between this and ordinary hail. It occurs mostly as short showers in squally weather on the back of a depression, and is affected also by any mountain slopes. Few observations other than those at Ben Nevis and Blue Hill Observatories existed for glazed frost. The distribution of dew and hoar-frost is hard to define because the results are only infrequently tabulated. R. S. R.

ASTRO-PHYSICS.

2034. *Some Measures of Solar Rotation at Different Levels in Chromosphere.* **J. Evershed.** (Roy. Astron. Soc., M.N. 85. pp. 607–609, May, 1925.)—Values of the solar rotation were obtained from photographs in 1922–23 of solar spectra with iron-arc comparison using a prism-spectrograph near the equator east and west in the H and K region, using a grating-spectroscope for D lines with a potash salt in the arc; in 1918, using the grating-spectrograph in the red region near to and including the H_α line; in 1908–11, using the H and K lines in sixty-one prominences photographed on the east and west limbs at mean latitude 31°. The mean height of the prominences above the photosphere was 46″; the mean heights, in the other cases, were derived from the measures of the author's eclipse plates in 1898 and 1900, and were assumed to be one-half the height to which the gases ascend in the chromosphere. The angular speed increases markedly with the height of the absorbing region; the stronger the line in the same plate of the H and K region, so also the rotation period increases. The deviation from plate to plate increases both with the height and the strength of the line, and is probably due to real change of velocity. The angular motion varies from 13°·6 for weak U.V. lines to 15° for H and K (calcium) and 16°·8 for the prominences. This last region is outside the chromosphere, and is apparently subject to violent conflicting movements, which extend downward through the chromosphere with diminishing amplitude.

A. S. D. M.

2035. *Variations in the Light of Asteroids.* **Margaret Harwood.** (Harvard College Obs. Circ. 269. [15 pp.], 1924.)—As well as showing variation in light according to their phases, it has been established that thirteen asteroids are intrinsically variable, and thirty-six others are suspected. A summary is here given of the data, including the results of forty-five observers, and various theories are discussed. The variation can usually be explained by rotation and a spotted surface, or by these combined with an elongated shape, but Eros is peculiar. M. A. E.

2036. *Variable Stars and the Ballistic Theory.* **C. Nordmann** and **C. le Morvan.** (Comptes Rendus, 180. pp. 1159–1161, April 14, 1925.)—The principles indicated by la Rosa [Abstract 1607 (1925)] are applied to the actual case of β Lyræ. It is shown that the principal star must be three times more brilliant in the red than the companion. Generally it can be seen that the larger star will always be the richer in the red rays of the spectrum, and so on this theory the smaller component will always be considerably the hotter. A. Wh.

2037. *Distribution of Hydrogen in a Star.* **S. Rosseland.** (Roy. Astron. Soc., M.N. 85. pp. 541–546, April, 1925.)—Hydrogen seems to play an important part in astrophysical phenomena, for its lines predominate in the emission spectra of gaseous nebulæ and early-type stars, and are characteristic of the spectra of novæ and long-period variables, and there is a conspicuous difference between their intensities in the spectra of giants and dwarfs. It is therefore desirable to inquire whether there is anything abnormal about hydrogen in stars, or whether these phenomena may result from the ordinary properties of hydrogen as observed in terrestrial laboratories. It is pointed out that the ratio of electric charge to mass for the hydrogen nucleus is twice as large as for any other element, consequently the spatial distribution of hydrogen in a star may differ radically from that of any other element. A mathematical discussion leads to the conclusion that if the core of a star is in true hydrostatic equilibrium (non-convective), and if it does not contain an enormous proportion of hydrogen, then hydrogen must be repelled from the core and strongly concentrated in the surrounding convective layer and at the surface. M. A. E.

2038. *Masses, Luminosities and Surface Temperatures of the Stars.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 85. pp. 394–403, March, 1925.)—The continuation of an earlier paper [Abstract 1599 (1925)]. The first portion of the paper is mainly mathematical, and then the theory is shown to accord well with the facts. If E/M is constant, the distribution of the giants but not of the dwarfs is explained. If stars are assumed to consist of two kinds of matter, one of which is incapable of conversion into free energy while the other decays normally, a type of evolution is predicted which will give the typical rise and fall in temperature. A more complex state of affairs where a great number of constituents decay at different rates would doubtless be a closer approximation to actual conditions.
A. Wh.

2039. *The Mass-Luminosity Relation.* **A. S. Eddington.** (Roy. Astron. Soc., M.N. 85. pp. 403-407, March, 1925.)—Jeans has recently criticised the author's results. [Abstract 1599 (1925).] It is pointed out that Jeans claims to treat the ratio of gas pressure to radiation pressure as a variable, but actually he develops two cases only, firstly where the ratio is zero and then when it is infinity. A substitution is mentioned which enables similar results to be obtained with great simplification.
A. Wh.

2040. *Formation of Comets by the Passage of a Star through a Nebula.* **E. Belot.** (Comptes Rendus, 180. pp. 1097–1100, April 6, 1925.)—The full problem of the trajectory of a massive star through a nebula involves so many variables that it cannot be solved. By approximate considerations it is easy to see how comets might be formed by the concentration of nebulous masses in front of the star. These would continue in their orbits and further concentrate behind the star. The violent pulsations set up, with corresponding fluctuations of radiation, would make this process intermittent. A. Wh.

2041. *Distances and Structure of the Spiral Nebulæ.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 85. pp. 531–534, April, 1925.)—If l be distance apart of the condensations in nebular arms; s its value corrected for foreshortening; q the distance of the nebula in parsecs; C its molecular velocity; ω its angular velocity of rotation; ρ the mean density of its nucleus; M the mass of a condensation; and L its luminosity; then the author points out that his theoretical formulæ, $l = \frac{1}{2}(\pi/\gamma\rho \times d\rho/d\rho)^{\frac{1}{2}}$; $C = l\omega$, give $C = 4 \cdot 8 \times 10^4$ cm. a sec. when the value of l at a distance from the nucleus is reduced to one-third, so as to give its value near the nucleus. [See Abstract 1587 (1925).] Dispensing with van Maanen's determinations of the angular velocities of the nebulæ, and H. Shapley's criticisms based on these for the author's distance of Messier 33 [see Abstract 2464 (1924)], and adopting Eddington's correlation of the luminosities and masses of the actual stars, the theoretical formulæ give M (in terms of the sun's mass) $= 2 \cdot 8 \times 10^{-14} C^2 qs$; and if the condensations in the nebular arms appear n magnitudes fainter than the sun at 10 parsecs,

$L = q^2 10^{-(2+0\cdot 4n)}$. If Hubble is correct that the variables in Messier 31 and Messier 33 appear to be of absolute magnitude -4, then for these stars the mass-luminosity correlation is that L varies nearly as $M^{1\cdot 8}$, and therefore q varies as C^{20}. Since C may be in error by a factor of 2, q may be in error by a factor of over a million. But taking any reasonable value of q, and assuming $s = 1$ (which is rough), $n = 13$, for Messier 31, the value $C = 5\cdot 4 \times 10^4$ cm. a sec., agreeing well with the previous value. It is of the order of magnitude of molecular velocities in a gas, thus confirming the hypothesis that nebular condensations are formed by gravitational instability in a gas; but the author finds that up to about 90 % of the matter in the arms might be in the solid or liquid state. If the lenticular shape of Messier 31 is due to its rotation, assuming Pease's formula for its line of sight velocity and Hubble's distance of 950,000 light-years, he finds the period $= 5\cdot 7 \times 10^{14}$ sec.; the mean density $\rho = 9 \times 10^{-22}$; a mean free path of 100 million km. if the nucleus is wholly gaseous (greater if partially solid or liquid); the diameter of the nucleus, $1\cdot 57 \times 10^{21}$ cm.; its mass 5×10^{42} grammes or 2500 million suns; its emission of light 400 million times that of the sun. He suggests that Messier 31 exemplifies a state intermediate between the typical spiral and the galactic system. A. S. D. M.

2042. *Theorem of v. Zeipel on Radiative Equilibrium.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 85. pp. 526–530, April, 1925.)—The theorem due to v. Zeipel, giving the rate of generation of energy in the interior of a star, is shown to be an approximation only, and which may, in fact, be subject to errors of the order of the quantity derived. It is shown that v. Zeipel's procedure is equivalent to putting two successive coefficients in a series of equations due to the author, equal to zero. Hence it is seen that all successive coefficients vanish, and the general theorem of which v. Zeipel's is a particular case loses its significance. It is pointed out that the equation of radiative equilibrium, $H = \frac{4}{3}\pi B = -\frac{4\pi}{3k\rho}\frac{d}{dx}(\mu T^4)$, is also in error to the same extent. A. Wh.

2043. *Radiative Equilibrium of a Star with Central Source of Energy.* **A. S. Eddington.** (Roy. Astron. Soc., M.N. 85. pp. 408–413, March, 1925.)—In order to throw light on the possibility of accounting for the discrepancy in the total radiation between theory and observation, an extreme case of radiative equilibrium is analysed, where the whole of the energy evolution is at the centre. Reduction of the results is very laborious, but one case is worked out. For a star of mass $5\cdot 02 \times \odot$, radius $11\cdot 35 \times 10^{11}$ cms, the magnitude difference corresponding to a central emission and the "usual" distribution of energy according to $\epsilon \propto T$ is $0^m\cdot 97$. Thus the discrepancy of the absorbtion coefficient cannot be accounted for by the most drastic alteration in the assumption as to the distribution of energy emission. A. Wh.

2044. *The Origin of the Solar System and Eddington's Theory of Stellar Luminosity.* **H. Jeffreys.** (Roy. Astron. Soc., M.N. 85. pp. 413–416, March, 1925.)—Recent developments of the theory of stellar luminosity modify considerably conclusions drawn previously as to the origin of the solar system. Previously it had been thought that, at the time when the planets were formed, the solar constant was greatly in excess of its present value, whereas it seems likely that the change has been slightly in the other direction. It was doubtful if the formation of oceans occurred at an early or late period of the earth's life. It now seems that they commenced to form when the earth was a few thousand years old. A. Wh.

2045. *Absolute Magnitudes of Objects in the Large Magellanic Cloud.* **H. Shapley** and **H. H. Wilson.** (Harvard Coll. Obs., Circ. 271. [8 pp.], 1925.)—Adopting the parallax already found for the Large Cloud of 0″·000029 [Abstract 1026 (1925)], absolute magnitudes have been derived for stars of the P Cygni and other special types, for clusters, and for nebulæ. It appears that many of the diffuse nebulæ are much brighter than the Orion nebula. M. A. E.

2046. *Occultations observed in 1923 and Comparison with Brown's Tables.* (Union Obs. S. Africa, Circ. No. 63. pp. 279–293, March 20, 1925.)—Reduction of 224 occultations of stars observed elsewhere than at Johannesburg, all being dark-edge phenomena, except in the case of Aldebaran. What is being sought is the time-error of the moon's ephemeris. The author believes that the deviations of the moon are not due to errors in x, y and z, but to errors in t, which errors must arise from irregularities in the period of rotation of the earth. He finds that the simple and unweighted mean of all the observations, rejecting none, gives $\Delta t = + 14\cdot 3$ sec. $(= + 7''\cdot 9)$, and similarly the mean of the amateur astronomer's observations (made in England) is $+ 14\cdot 4$ sec. $(= + 7''\cdot 9)$. During the year 1923 the moon's time-error Δt decreased from $+ 14\cdot 8$ sec. to $+ 13\cdot 4$ sec. (in arc, from $+ 7''\cdot 9$ to $+ 7''\cdot 4$), and there is no certain indication of any period term. A. S. D. M.

2047. *Spectrum of ϕ Persei (Type BOpe).* **W. J. S. Lockyer.** (Roy. Astron. Soc., M.N. 85. pp. 580–607, May, 1925.)—An investigation of fifty-five plates of ϕ Persei, between H_β and H_δ, with the prismatic camera, for cyclical changes in the hydrogen lines and for the nature and origin of the other sharp, bright lines and the sharp and hazy dark lines. Each hydrogen line consists of a broad absorption band on which are superposed two bright lines symmetrically placed and separated from each other by a strong absorption line. The relative intensities of the two bright components of any one hydrogen line change in a gradual and progressive manner, and were determined by eye and by the wedge-measuring machine. A table of these values is given for H_β and H_γ, and indicates a mean period of 128·7 days; by using a date of minimum of Jordan's in 1909 this mean value is reduced to 126·8 days. A good approximate *period* for a binary may be found when the hydrogen lines are of the double-bright nature, and the *form* of the velocity curve when the observations are well distributed. Double-bright lines of ionised iron, calcium and titanium behave in a similar way as the hydrogen lines, and lines so placed are also found in γ Cas., π Aqr., μ Cen., H.D. 20,336, 7 Tau., 25 Ori., ψ Per., H.D. 161,114, and the companion to o Ceti. In ϕ Per. a few absorption lines are also seen as very sharp lines or as very nebulous lines at different velocity phases. A table is given of the changes of intensities of both bright and dark lines, the outstanding feature being that the absorption lines of hydrogen and calcium behave somewhat alike, both being very weak, exhibiting least absorption at the phase of negative velocity and greatest prominence at the phase of positive velocity. All the bands suggest an underlying short-period variation at work. Summaries are given throughout of previous work by other observers on all these various lines. The present investigation suggests that ϕ Persei ought to be a variable star with a period of 126·8 days, having an amplitude of variation of about two- or three-tenths of a magnitude, its maximum brightness occurring at epochs of maximum negative velocity, and a search has been made for such small variations, but without success. Two plates are given of a comparison of ϕ Persei with α Cygni and γ Orionis, and of its own spectrum at different phases. [See Abstract 2225 (1924).] A. S. D. M.

2048. *Stellar Magnitude Scales of Astrographic Catalogue. Provisional General Survey.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 85. pp. 610–624, May, 1925.)—In 1909 it was proposed "that the number of images recorded under each unit of the magnitude scale be counted and tabulated" [see Abstract 999 (1909)]. The main purpose is to coordinate the magnitude scales of the forty zones (each of 2° in declination) from + 62° to − 41°. N represents the total number of stars per square degree brighter than a specified limit, and $\log N_0$ corresponds on the galactic equator to $\log N_\gamma$ in galactic latitude γ. The stars are grouped by the values of N_0. The author considers, after the galactic condensation has been removed to the first approximation, (*a*) the distribution of the stars of mean magnitude 11·3 (the mean value of $\log N_0 = 1{\cdot}50$), and (*b*) the variations of this distribution for one magnitude, but this last is not critically discussed. He finds that the results suggest that there are systematic features of stellar distribution not hitherto realised that can be explored profitably by use of the magnitude determinations of the astrographic catalogue, which ought to be completed without undue delay. A. S. D. M.

2049. *Frequency Distribution of some Measured Parallaxes and of Parallaxes Themselves.* **E. B. Wilson** and **W. J. Luyten.** (Nat. Acad. Sci., Proc. 11. pp. 270–274, May, 1925.)—If the error of measurement is comparable in magnitude to the quantity determined, the frequency functions of a set of quantities and of their measures may be decidedly dissimilar. The authors have taken 313 determinations of parallax, by the Allegheny, McCormick and Mt. Wilson Observatories, of stars between 5th and 6th magnitudes, counting each measure separately. The frequency curve is very skew, but looks like a logarithmic transform, and is, in fact, normal in $x = \log_{10}(\overline{\varpi} + 20)$, the parallax being taken in thousandths of a second of arc. But when the frequency distribution of these parallax-measurements passes to the frequency function of the parallaxes themselves (as determined by the method given by Whittaker and Robinson in *The Calculus of Observation*) the solution is very unsatisfactory. When, however, the authors determine the logarithmic transform (with the origin drawn in from $\overline{\varpi} = -20$ towards $\overline{\varpi} = 0$), which has its first three moments identical with those computed by Whittaker and Robinson's method, the new distribution is an improvement. Two diagrams are given; the first a plot on logarithmic-probability paper of the distribution of observed parallaxes with scale giving $\log_{10}(\overline{\varpi} + 20)$ and of the fitted logarithmic transform with scale giving $\log_{10}(\overline{\varpi} + 6{\cdot}3)$; the second giving two curves of the distribution of parallaxes and of the parallaxes themselves, exemplifying the serious differences between two such frequency distributions. A. S. D. M.

2050. *Effect of Varying Mass on Binary Systems.* **E. W. Brown.** (Nat. Acad. Sci., Proc. 11. pp. 274–279, May, 1925.)—Amongst other problems, Jeans has considered [see Abstract 1025 (1925)] the effect on a variable mass M of a central acceleration M/r^2, and taking the mean value of $1/r = 1/a$ (where $2a$ is the major axis in an elliptic orbit), he deduces $Ma = \text{const}$. The author finds that $a = \text{const.}$, since Jeans assumes erroneously that the disturbed mean value of $1/a$ gives the disturbed value of $1/r$, whereas there is a secular term arising from the periodic part of $1/r$. In effect, both *mean distance* (a) and *eccentricity* (e) increase as M decreases, the relation between these rates being expressed by the equation $a/e - ae = \text{const.}$, and the areal velocity is constant. The author discusses three hypotheses of the effect of decrease of mass in a binary system (masses m_1 and m_2): (1) That assumed by Jeans, mass × acceleration = force; (2) the usual form of the second law of motion, rate of change of momentum = force; and (3) $d^2/dt^2(\lambda x) = \lambda x \times$ force along the x-axis, where λ is a function of the masses only. In both (1) and (2), unless $m_1 = m_2$ throughout or $m_2 = 0$ (which cases give constant velocity), the velocity of the centre of mass increases, but in (1) the angular momentum decreases and the areal velocity remains constant, and in (2) the angular momentum is constant and the areal velocity increases. In (3) the rates of a and e depend on the values of m_1, m_2, and consequently on the rates of change; if $2m_2 < 3m_1$ for all time M diminishes with m_1, m_2; if $m_2 < 2m_1$, and the eccentricity not too large, the distance diminishes with m_1, m_2, which is of interest in view of the determinations of the relative masses in stellar binary systems. Hypothesis (2) shows that the velocity of a star as well as that of the centre of mass of a system increases, agreeing with the increase of velocity with age in Russell's scheme of evolution. A. S. D. M.

2051. *Reduction of the Harvard-Groningen Durchmusterung to the International System of Magnitude and Colour.* **F. H. Seares, Mary C. Joyner** and **Myrtle L. Richmond.** (Mt. Wilson Observat. Contrib. No. 289. Astrophys. J. 61. pp. 303–319, May, 1925.)—The Durchmusterung in HA, 101, 102, 103, gives the brightness of stars in Selected Areas 1–206, to a limiting magnitude of about 16. Many of these appear in the Mt. Wilson Catalogue of Selected Areas, which includes Areas 1–139. It is shown that the Catalogue is on the international photographic scale. The Durchmusterung can therefore be reduced to the latter scale by direct comparison of magnitudes for stars observed in common. The Durchmusterung magnitudes for the northern hemisphere, measured with the Metcalf 16-in. telescope, are affected by a large colour equation. This was determined from the central stars of the areas, whose colour-indices are known. The complete reduction thus found from eighty stars for the Metcalf telescope before the objective was re-ground is

$$\mathrm{MW} - \mathrm{DM} = +\,0{\cdot}06(\mathrm{DM} - 6) + 0{\cdot}21\mathrm{C}(m \lesssim 10) \quad . \quad . \quad (9).$$

The scale-divergence is the same as that of HA, 71, No. 3, as it should be. Corrections for each area, for scale and colour combined, were derived from the stars common to the two catalogues (Table III). With allowance for colour equation based on the mean colour-index of stars of different magnitudes, it is found that to $m = 13$ the scale correction of the DM is the same as that of HA, 71, No. 3 (Table IV), but for fainter stars there is an appreciable divergence. The fluctuations in the corrections from area to area are large, and obscure the systematic difference for stars of high and low galactic latitude, which depends on the fact that the former are redder than the latter. For statistical purposes the separate areas should be reduced to the international system with the aid of Table III. AUTHORS.

2052. *Some Relations between Magnitude Scales.* **F. H. Seares.** (Mt. Wilson Observat. Contrib. No. 288. Astrophys. J. 61. pp. 284–302, May, 1925.)—The principal purpose is the reduction of the Harvard visual scale to the Mt. Wilson photovisual system. Incidentally, it is necessary to discuss the relation of this system to the photographic and photovisual magnitudes of King and the visual results of the Potsdam Durchmusterung. A direct comparison of Polar Sequence measures gives the values of the colour equation, which seems to depend on the magnitude, and the scale correction for the Harvard scale between $m = 4$ and 13 (Table II and [2]). King's extra-focal measures define scales which are sensibly parallel to MW and H results for $m < 4$ (Tables III–V), and extend the series of colour coefficients, but leave the zero-point correction to the Harvard visual magnitudes of bright stars rather uncertain. The result, however, is confirmed by comparing, in the critical region, the PD and HR and the PD and MW systems. The scale corrections for Harvard are approximately $-0{\cdot}08$ to $m = 5$; $+0{\cdot}07\ (m - 6)$ for $m = 5$ to $9{\cdot}5$; and $-0{\cdot}08\ (m - 12{\cdot}5)$ for $m = 9{\cdot}5$ to 13. The changes in the run in the differences correspond to the division-points between measures made with the 2-in., 4-in. and 12-in. meridian photometers. The comparison of Harvard and Potsdam is based mainly on the data of Müller and Kempf, and leads finally to the scale and colour corrections for the PD (Table VI), confirmed in part by direct comparison of PD and MW magnitudes for Polar Sequence stars. AUTHOR.

2053. *Photometric Sequence in Pleiades.* **H. L. Alden** and **S. A. Mitchell.** (Astron. J. 36. No. 850. pp. 73–76, June 5, 1925.)—The Rumford wedge photometer scale depends upon laboratory measures with polarising prisms and a rotating sector, and upon observations at the telescope with a shade glass whose absorption is well determined. The two methods of calibration agree well, but it is desirable to check the scale with other well-defined scales. Thus the McCormick scale was more extended than the mean of Lick, Yerkes and McCormick by 4·7 % in a comparison of stars of the 15th magnitude. The present comparison is with a selected sequence of stars in the Pleiades given in Harvard Annals, 71, 53, and indicates a discontinuity in one scale or the other between the 9th and 10th magnitudes. A comparison with Graff's Photometrische Durchmusterung der Pleijaden shows that the discrepancy is in the Harvard scale. A table of this is given. A comparison with the Mt. Wilson photovisual magnitudes gives an indirect comparison with the North Polar Sequence, and shows that the difference between the two scales is less than 1 %. Conclusions cannot yet be drawn regarding the colour equation of the McCormick magnitudes. The scale is not greatly different from the absolute scale defined by Pogson's ratio. A. S. D. M.

2054. *General Distribution of Cosmical Velocities.* **G. Strömberg.** (Nat. Acad. Sci., Proc. 11. pp. 365–370, June, 1925.)—Fifty groups of all known classes of objects have been taken on the basis of spectral type, nebulous character, period of light variation, etc. B to M stars have been subdivided on the basis of proper motion (μ) and apparent magnitude (m), a certain quantity (H) being computed which is connected with the absolute magnitude (M) and the linear tangential motion (T in km./sec.), so that $\mathrm{H} = m + 5 \log \mu = \mathrm{M} + 5 \log \mathrm{T} - 8{\cdot}378$. Stars of a certain spectral type and nearly the same intrinsic brightness and velocity dispersion can thus be combined in the same groups, for each of which the velocity distribution was described in terms of the constants of the ellipsoidal distribution law. The group-motion was shown to vary from about 12 km./sec. for the Cepheids of long period to about 300 km./sec. for stars of maximum velocity dispersion, globular clusters, and spiral nebulæ, giving a steady increase along a definite axis with increase in dispersion. It is independent of spectral type, mass, etc., but varies with velocity dispersion, as shown in the quadratic relation, $y = -pb_2 + \beta$, $p = 0{\cdot}0192$ sec./km., $\beta' = -10$ km./sec., where the y-axis is in the direction of the shift, and b is the dispersion along an axis parallel to the y-axis. For objects other than B stars and highly luminous A stars the velocity-distribution can be written in a simple form :—

$$\mathrm{F}(xyz)dxdydz = \exp.[-p(y-\beta)] \times \sum_v \mathrm{A}_v \exp.\left[-\frac{(x-\alpha)^2}{2a_v^2} - \frac{(y-\beta)^2}{2b_v^2} - \frac{(z-\gamma)^2}{2c_v^2}\right]$$

The function in the summation sign is a symmetrical distribution whose centre has the velocity 14·8 km./sec. in the direction 85°·7, − 22°·0; the functional factor $\exp.[-p(y-\beta)]$ seems to be constant for all groups. In our neighbourhood the motions of stars are determined not only by the gravitational field due to a local system of stars, but also by another field connected with the system of globular clusters and spiral nebulæ; or there is a fundamental frame or medium referred to in which high cosmic velocities are non-existent. A. S. D. M.

2055. *Distribution of Stars with Respect to Magnitude and Galactic Latitude.* **F. H. Seares** and **P. J. van Rhijn.** (Nat. Acad. Sci., Proc. 11. pp. 358–364, June, 1925. Nature, 115. pp. 948–950, June 20, 1925.)—A study of the distribution of faint stars in the 139 Selected Areas of Kapteyn has been completed, and a detailed discussion will be published, but some matters of general interest are here summarised. The results indicate an underlying statistical unity of the stellar system, and the importance of the Milky Way as a structural feature. The total number of stars down to the 20th visual magnitude is about 10^9. The ratio of total numbers for successive magnitudes falls off rapidly with decreasing brightness, and most rapidly in the direction of the galactic poles, a result evidently related to the flattened, watch-shaped form of the system. Ninty-five per cent. of all stars are within 20° of the galactic plane. The number of stars beyond the range of our most powerful telescopes must be many times greater than the number of visible stars; but 98 % of starlight is contributed by the visible stars brighter than 20th magnitude, and the largest share comes from those of about the 12th magnitude. M. A. E.

2056. *Measurement of the Spectroscopic Binary Star Mizar with the Interferometer.* **F. G. Pease.** (Nat. Acad. Sci., Proc. 11. pp. 356–357, June, 1925.)—This star is within the resolving power of the 20-ft. Michelson interferometer attached to the 100-in. telescope at Mt. Wilson, and a set of observations of the separation of the components was made in April, 1925. The results confirm the position-angles, and hence the orbit, deduced from spectroscopic data and parallax. M. A. E.

2057. *New Classes of Secular Solutions in the Problem of Three Bodies Applied to the Motion of an Asteroid.* **W. W. Heinrich.** (Roy. Astron. Soc., M.N. 85. pp. 625–639, May, 1925.)—Classes of solutions previously discovered do not admit of development towards the condition that the rotation of the apse of the asteroid orbit vanishes with the eccentricity of the planet's orbit. Two classes of solutions are derived which satisfy this condition. The paper is mainly mathematical. A. Wh.

2058. *Newton's Method of Determining Parabolic Orbits.* **A. N. Kriloff.** (Roy. Astron. Soc., M.N. 85. pp. 640–656, May, 1925.)—The author considers that the method described in the *Principia*, Book III, Proposition XLI, and preceding Lemmas is unduly neglected, and "the aim of this paper is to call the attention of students of astronomy to these wonderful pages of the *Principia*, and to show that they are as perfect as anything else he ever wrote." A criticism of Bauschinger is shown to be based on an incorrect statement of the method, and, by examples, it is demonstrated to be capable of giving results to any required accuracy. A. Wh.

2059. *The Eccentricity of Fluid Planets and the Rotation of the Inner Planets.* **J. Boccardi.** (Comptes Rendus, 180. pp. 1647–1650, June 2, 1925.)—Considering the case of a body revolving round a centre of attraction and which always turns the same face to the centre, it is discussed whether the ellipticity assumed by a planet, if it is fluid, can explain the stability of the motion. For the earth it is found that the two axial excesses will be 1·2 and 4·8 metres, and for Venus 0·58 and 2·3 metres only. If A, B and C are the principal moments of such an ellipsoid, $\gamma = (B - A)/C$. For Venus $\gamma = 0{\cdot}000000283$, and this is far too small to be considered of practical significance. The small inequality of the moments produced in this way cannot explain the observed stability. A. Wh.

2060. *Variations in the Polarisation of the Light from Mars due to Clouds.* **B. Lyot.** (Comptes Rendus, 180. pp. 1645–1647, June 2, 1925.)—Previous measurements of the polarisation of the light from Mars [Abstract 2220 (1924)] have shown that it is very similar to that of the moon. Further measurements are now given for a further cycle, and it is found that the observations are repeated up to a certain point, but that then, for a period of about three months, the polarisation falls greatly below its normal value. This is due to cloud or mist in the Martian atmosphere, and with a high magnification it is shown that the distribution of cloudy areas entirely alters in the course of three weeks. A. Wh.

LIGHT.

2061. *Physical Optics.* (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 549–560, May, 1925.)—A review of the developments made in all branches of the subject as recorded in various papers published in the past few years. Attention is drawn to the slow advance in the reconciliation of the quantum and wave theories, upon which the views of prominent workers are briefly referred to. A. B. C. L.

2062. *The Colour Theory of Colloidal Metallic Suspensions.* **G. Jobst.** (Ann. d. Physik, 76. 8. pp. 863–888, June, 1925.)—The present paper is essentially an amplification of Mie's theory of the colours of colloidal solutions for the case of coarse metallic suspensions [Abstract 594 (1908)], utilising the more recent representations of the Bessel functions as developed by Debye in the form of semi-convergent series. For the case of coarse particles the methods indicated by Mie do not lend themselves to numerical computation, as they necessitate dealing with as many members of the resulting series as are indicated by the number 2π-particle radius/wave-length. One is therefore compelled to effect an analytical summation of these series, which would seem impossible without applying the Debye formulæ. We thus arrive at a radiation and absorption law which holds good with sufficient accuracy for the entire field 2π-particle radius/wave-length, and may be linked up with Mie's calculations. A recent paper by Shoulejkin [Abstract 2714 (1924)], in which the author employs Mie's methods, reveals the enormous difficulties of computation for the case of coarse particles. There can be no doubt that in this case Maxwell's theory and the calculation with the optical constants of the compact material are inadmissible, though for smaller particles they may lead to theoretical results in harmony with experience. The assumption of a simple proportionality between radiation or absorption and the concentration of colloidal solutions is also completely justified, as is shown by, amongst others, R. C. Tolman. The paper is divided into three chapters. Chap. I contains the establishment of the formulæ of total radiation and absorption for a small sphere; Chap. II shows the simplification of these formulæ by the introduction of Debye's semi-convergent development and the summation of the resulting series; Chap. III discusses the solutions and Mie's results. The treatment of the problems is entirely mathematical. E. F.

2063. *Metallic Lustre. Part II.* **W. D. Bancroft** and **R. P. Allen.** (J. Phys. Chem. 29. pp. 564–586, May, 1925.)—Metallic lustre is observed when sufficient light appears to come from a single surface with suitable variations in space or time. The crystals of metals and many sulphides, phosphides, silicides, selenides, tellurides and arsenides are so opaque that the light is reflected practically from one surface, the metallic lustre being intensified if the surface is not too smooth. Interference colours of thin films—*e.g.* birds' feathers or oil films—show metallic lustre, while with multiple films the lustre is metallic only when the observer is so far away that the film thickness is negligible. Total reflection and selective surface reflection give metallic lustre. Synchronous intermittent lighting of a rotating parti-coloured disk, or stereoscopic lustre, gives the sensation of metallic lustre, which may also be shown by self-luminous bodies. [See Abstract 2471 (1924).] B. W. C.

2064. *Reflection from Metallic Surfaces. Parts I and II.* **I. Ebeling.** (Zeits. f. Physik, 32. 7. pp. 489–501, 1925.)—The peculiar selectivity shown in the spectra, due to the reflecting power of metals—as, *e.g.*, the sharply defined minimum at $\lambda = 3160$ Å. in the case of silver—shows a strong dependence on temperature. In the case of copper, the powers of reflection and absorption indicate a dispersion in bands, and for a weak minimum reflection show small relationship to temperature. These points were investigated by means of a photoelectric cell. The paper concludes with a discussion, arising from actual records and observations, regarding the relation between the optical properties of metals in the colloidal and ordinary states respectively, and also a comparison of the phenomena when the metal exists as solid or as vapour. The results are recorded by means of curves, tables and reproductions of photographs of spectra. S. G. B.

2065. *Chromatic Visibility Coefficients by the Method of Least Squares.* **D. B. Judd.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 635–651, June, 1925.)—After a brief *résumé* of other methods, the author in this paper assumes the true coefficients to be those values which, when used to weight the excitation curves, will cause them to summate to an approximate visibility function, the sum of the squares of whose errors from the accepted visibility function shall be a minimum. A mathematical analysis leading to the discovery of the coefficients which yield errors, the sum of whose squares is a minimum, is given, which yields three equations as follows :—

$$\begin{aligned} K_1\Sigma RR + K_2\Sigma RG + K_3\Sigma RB &= \Sigma RL \\ K_1\Sigma RG + K_2\Sigma GG + K_3\Sigma GB &= \Sigma GL \\ K_1\Sigma RB + K_2\Sigma GB + K_3\Sigma BB &= \Sigma BL \end{aligned}$$

of which all quantities except K_1, K_2, K_3 (the chromatic visibility coefficients referring to the red, green and blue excitations respectively) can be evaluated from one or the other of the two sets of data that are under the process of coordination. The values resulting from the solution of these equations are :—

$$\begin{aligned} K_1 \text{ (red excitation)} &= 0\cdot8481 \pm 0\cdot0360 \\ K_2 \text{ (green excitation)} &= 1\cdot0062 \pm 0\cdot0333 \\ K_3 \text{ (blue excitation)} &= 0\cdot01290 \pm 0\cdot01431 \end{aligned}$$

A series of tables and curves is given and the brightnesses of a set of papers illuminated by an equal energy spectrum calculated in three different ways : (1) By Troland's coefficients ; (2) by the least square coefficients ; (3) by a theoretically rigorous graphical method, against whose results the first two sets of figures are checked. T. C. H.

2066. *The Optical Constants of Crystals of Selenium and Tellurium for Wave-lengths from 3000 to 5000 Å.* **R. F. Miller.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 621–634, June, 1925.)—The measurements were made by a photographic method for two positions of the crystal, (1) with the optic axis parallel, and (2) with the axis perpendicular to the plane of incidence. Two sets of optical constants were found for each substance. For selenium, in the parallel position the index of refraction was found to vary from 3·4 to 4·4, and the reflecting power from 0·38 to 0·46; in the perpendicular position the index varies from 2·3 to 3·1, and the reflecting power from 0·41 to 0·34. For tellurium, in the parallel position the index varies from 1·9 to 2·9, and the reflecting power from 0·10 to 0·27; in the perpendicular position the index varies from 1·7 to 2·7, the reflecting power from 0·09 to 0·23. The average error is estimated to be about 5 %. The accuracy is greatest for the middle range of wave-lengths, 3500–4000 Å. AUTHOR.

2067. *The Use of Calcspar Lenses as Polarisers for Strong Beams of Light.* **W. Schütz.** (Zeits. f. Physik, 32. 7. pp. 502–504, 1925.)—A calcspar lens cut parallel to the optic axis of the crystal possesses two foci for natural light, in accordance with the refractive indices for polarised light, which is parallel or perpendicular to the axis. The ratio of the two focal lengths is 1·35. This difference of refractive power is used in the present case. The source of light is brought to a focus at two places. The ordinary ray is eliminated by means of a screen placed in its path at the focus, and thus the remaining cone of light is linear polarised and of considerable intensity. The above arrangement is suitable for all wave-lengths, and is an efficient substitute for Nicol prisms and the accompanying optical system necessary therefor. S. G. B.

2068. *A New Type of Nephelometer.* **R. Kingslake.** (Optical Soc., Trans. 26. 2. pp. 53–61; Disc., 61–62, 1924–1925.)—A new type of nephelometer is described, which provides an accurate optical method of measuring a minute amount of precipitate by means of the turbidity it produces in solution. Light is passed into the end of a tube containing the solution, and the intensity of the scattered light is measured by a special form of wedge photometer. A description is given of the means by which stray light can be kept from the eye during observations, and an actual example is included to illustrate the use of the instrument. AUTHOR.

2069. *Some Notes on Nephelometry and a Suggested Sensitive Test for the Stability of Explosives.* **A. F. C. Pollard.** (Optical Soc., Trans. 26. 2. pp. 63–73, 1924–1925.)—The importance of nephelometry to industry and the chemist is indicated, and the unsatisfactory state of the theory of the molecular as well as the colloidal scattering of light is briefly discussed. An example of the high sensitivity of nephelometric methods is given in a description of some preliminary work upon a suggested sensitive test for the stability of nitro-explosives and the simple instrument designed for the purpose. AUTHOR.

2070. *On the Depth of the Images of Optical Systems.* **H. Krüss.** (Zeits. Instrumentenk. 45. pp. 213–220, May, 1925.)—An investigation, mainly mathematical, of Richter's work. [See Abstract 1062 (1925).] E. F.

2071. *Depolarisation of Light in Optically Non-homogeneous Media.* **G. I. Pokrowski.** (Zeits. f. Physik, 32. 9. pp. 713–720, 1925.)—Investigation was made of the relationship between the relative amount of polarised light in the ray which passed through the optically non-homogeneous body, the thickness of the layer, the concentration of the light-scattering elements, and the size of the particles. The optically non-homogeneous bodies were gelatine, suspensions of boric acid in petroleum, calcspar in glycerine, and vanadium pentoxide suspension. The results showed that when plane polarised light passes through an optically non-homogeneous body or a suspension a part of the light is depolarised. The portion of the beam which passes through the non-homogenous body is depolarised; the portion passing through the inter-spaces retains its polarisation. Formulæ are developed connecting the relationship between the relative amount of polarised light which passes through the optically non-homogeneous medium, the thickness of the layer, the concentration and magnitude of elements. The formulæ are confirmed by experimental results. The change of depolarising power of vanadium pentoxide suspensions, with time, can also be empirically calculated by aid of the formulæ. [See Abstract 1612 (1925).] F. J. B.

2072. *Dispersion.* **L. S. Ornstein and H. C. Burger.** (Zeits. f. Physik, 32. 9. pp. 678–680, 1925.)—Continuation of Abstract 1068 (1925). Shows that dispersion can be explained on a light-quantum theory if the inertia of the electric charge in the atom and the causes of scattering be taken into account. A. D.

2073. *Electrical Birefringence of Limonene.* **R. de Mallemann.** (Comptes Rendus, 180. pp. 1483–1485, May 18, 1925.)—The author has determined the Kerr constant of limonene by the general method for measuring the electromagnetic birefringence of active substances previously described [see Abstracts 1124 and 2717 (1924)]. Brief details are included. The data show the rotatory power of limonene to remain invariable, the electrical birefringence to be positive, and the Kerr constant to lie between that of benzene and toluene, and to be nearly four times greater than that of pinene, a difference ascribed to the double band in the side chain. H. H. Ho.

2074. *The Friese-Greene Process of Colour Cinematography.* **C. H. Friese-Greene.** (Roy. Soc. Arts., J. 73. pp. 552–558; Disc., 558–560, May 1, 1925.)—A general description of what is known as the "additive" method. A. E. G.

2075. *A New Method for Photographic Spectrophotometry.* **L. A. Jones.** (Eastman Kodak Co. Research Lab. Comm. No. 221. Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 561–572, May, 1925.)—The photographic method has many advantages to recommend its adoption, even for work in the visible region. Some very good instruments have been devised, and results of satisfactory quality are being obtained by their use. The following peculiarities of photographic materials which may give rise to errors when these materials are used for measurement of radiation intensities are discussed—intermittency effect; failure of the reciprocity law; gamma-wave-length effect; non-uniformity of effective sensitivity, and errors of development. The method here proposed meets the requirements given, and the precision obtainable should be limited only by the exactness with which the mechanical and optical requirements can be met and by the error involved in the determination of density equality. For a description of the apparatus and method of carrying out experiments reference must be made to the original paper. A. E. G.

2076. *Chemiluminescence and Heteropolar Combination.* **A. Petrikaln.** (Zeits. f. Physik, 32. 8. pp. 569–574, June, 1925.)—Heat radiation in the decomposition of the iodide of Millon's base. The resonance lines in the luminescence spectrum from the same. The probable quantum path of the combination electron between Hg and N atoms in the iodide of Millon's base. [See Abstract 2493 (1924)]. A. D.

2077. *The Extinction of Resonance Fluorescence by Mercury-Vapour.* **H. A. Stuart.** (Zeits. f. Physik, 32. 4. pp. 262–272, 1925.)—The extinction curves were taken for a series of gases, and the experimental details so chosen that the disturbing influences of pressure increase and depolarisation were avoided. The curves showed that the radius of impact of the excited mercury atoms has approximately three times the value of the radius as given by the kinetic gas theory. It is also seen that the gain due to impact can be accounted for by two different methods. The gains up to 100 % are shown for O_2, H_2 and CO down to 0·03 % for helium. The conclusion gives a note of the sources of error and their influence on the accuracy of the results. The paper is experimental throughout. S. G. B.

2078. *Cells with Large Electrical Resistance producing Radiations.* **E. Bodin.** (Comptes Rendus, 180. pp. 1731–1733, June 8, 1925.)—The author, in conjunction with Reboul, has previously shown that various salts or oxides send out radiations of short wave-length when an electric current passes through them [Abstract 2755 (1924)]. The various substances are compressed into blocks or pastilles, and their resistance determined by measuring the current passing, with 1500 volts, between the ends. They form three groups—those which behave as insulators; those which allow measurable currents to pass and show no peculiarities in the conduction of electricity; those which conduct feebly the current for a given voltage, diminishing with time, the limiting current not being, in general, proportional to the potential. The last group includes the greater number of the substances investigated, including HgO, $HgSO_4$, Hg_2SO_4, $Fe_2(SO_4)_3$, $CuSO_4$, etc. It is substances of this group which, with suitable voltages, emit radiation. The distribution of potential in the different substances was investigated when current flowed through the blocks; in Group 3 it did not correspond to that due to pure conductivity in accordance with Ohm's law. Using HgO, for example, with 900 volts between the terminals, the drops near the terminals could reach 500 or 600 volts, while with alum there was a drop of 370 volts at the positive pole and 190 at the negative. H. N. A.

2079. *The Selection Principle and Needle Radiation.* **Erna Weber.** (Zeits. f. Physik, 32. 5. pp. 370–383, 1925.)—The present paper investigates the problem as to whether the Rubinowicz selection principle [Abstract 46 (1919)] retains its validity when the radiation emitted from an electron of an atomic system takes the form of Oseen needle radiation. The calculations now undertaken lead to the result that the selection principle holds for a force-free atom, but fails when an external electric field is introduced. The existence of an oscillation field is indicated which does not emit radiation, but obeys the Maxwell equations. The paper is entirely mathematical. H. H. Ho.

2080. *A List of Ultimate and Penultimate Lines of Astrophysical Interest.* **H. N. Russell.** (Mt. Wilson Observat. Contrib. No. 286. Astrophys. J. 61. pp. 223–283, May, 1925.)—The very rapid development of the analysis of complex line-spectra makes it desirable to prepare a preliminary list of lines of astrophysical interest for which the spectroscopic and energy-relations are known. A brief summary of the theory is given, followed by a list of lines, the elements being arranged in order of the successive groups of the periodic table, and the individual lines in order of the energy-level of origin within the atom. A bibliography of the more important recent papers is appended. The name " ultimate lines " is suggested for those lines which originate in the lowest energy-level (or normal state) of an atom (whether neutral or ionised) or in another state very close to this. Lines originating in neighbouring but higher energy-levels may be called " penultimate lines " ; those originating in still higher levels, " ante-penultimate lines." Ultimate lines, as here defined, are nearly, but not quite, synonymous with the raies ultimes of de Gramont. The difference is discussed in the text. The meaning of the terms " flame," " arc," and " spark lines " is also discussed. An index to the table has been made in which the elements are arranged in the alphabetical order of their chemical symbols. AUTHOR.

2081. *Methods for Determining Transition Probabilities from Line Absorption.* **J. C. Slater.** (Phys. Rev. 25. pp. 783–790, June, 1925.)—The various steps are discussed, practical methods being given for performing the calculations. The absorption coefficient can be found by the exponential law from knowledge of the intensity of absorbed and non-absorbed light. In doing this, the intensity curve must be corrected for slit width, and a simple method for this, applicable when there is good resolution, is given. Also methods are given for fitting constants of the ordinary formula for absorption coefficient in a spectral line to the observed data. Several points connected with half-breadth, failure of the exponential law with poor resolution, are discussed, and finally formulæ are given for finding the atomic transition probabilities from the constants of the absorption formula. AUTHOR.

2082. *Correctness in the Ultimate Structure of Spectral Lines.* **G. Joos.** (Phys. Zeits. 26. pp. 380–382, June 5, 1925.)—Values are given of the wave-lengths of the components of the Cd triplet $2p - 2s$, and it is shown that, with the greatest probability, for this triplet and the Bi line 4722, a further quantum number exists for which the same principle of selection holds as for the inner quantum. Also the difference terms are, within the limits of error, an exact multiple of a basic difference which for Cd and Bi (perhaps accidentally) is identical. R. S. R.

2083. *Electrically-broadened Spectral Lines.* **M. C. Johnson.** (Phys. Soc., Proc. 37. pp. 249–257 ; Disc., 257–258, June, 1925.)—A linear relation between broadening of the Balmer lines and average current density has been accepted for broadening up to 20 Å. The present work describes an investigation of a finer range, up to 1 Å., by means of a twenty-plate echelon grating, in which the above relation is shown to be an approximation. Concentration of ions is taken as the controlling factor, assuming Stack's hypothesis. Broadening without change of current was effected by a magnetic field, and the several effects involved are accounted for on the theory that line width depends on the number of charges which surround an emitting particle. A thermionic method was also tried for varying line-width.

In reply to the discussion it is stated that work on fine structure is being carried out. F. S.

2084. *Energy Levels in Band-Spectra.* **O. S. Duffendack.** (Astrophys. J. 61. pp. 209–222, May, 1925.)—While the radiating potentials of monatomic gases can usually be definitely connected with lines of the series spectra of the elements, those of diatomic and multiatomic gases frequently cannot. This has led several investigators to suggest that the potentials are for the molecule, but they have not been connected with the band-spectra of the substances. The connection of these radiating potentials with the band-spectra is pointed out in this paper. A brief synopsis of the present methods of analysis of band-spectra is given, and energy-level diagrams illustrating typical electronic and vibrational shifts are shown and discussed. Two types of grouping of bands are illustrated. The normal state of the molecule is that of the zero electronic and vibrational states coupled with some rotational state m. Consequently, the first band system should consist of a single set of bands whose frequencies are related in a second Deslandres progression, but succeeding systems should consist of groups of bands. The extent of a band system is limited by the overlapping of energy levels, by the stability of the molecule, and by the ionisation of the molecule. The minimum radiating potential of a system is the potential of the zero vibrational level. The radiating potentials may be experimentally determined by photographing the spectra excited by electron impacts of increasing energy. References are made to experiments of this kind. The zero level of the ionised molecule is discussed. AUTHOR.

2085. *Structure and Distribution of Band-Spectra.* **H. Deslandres.** (Comptes Rendus, 180. pp. 1454–1460, May 18, 1925.)—A *résumé* of previous work is given, in which it is shown that the frequencies of lines in band-spectra of simple compounds of C, N and O can be represented by a formula of which one term is $K = qd_1$, where q is a whole number and d_1 is the elementary frequency 1062·5. The author has now taken up the question of infra-red band-spectra, and finds the term in question is now $K = q \,.\, d_1/r$, in which r is another whole number. A table of absorption bands for O_2, CO, HCN, NH_3, H_2O and CH_4 is given, from which it appears that the value of K is best expressed as $K = qd_1/r \times s$, in which s is a third whole number equal to the number of atoms in the molecule of the gas. **Errata** (*ibid.*, p. 1707, June 2, 1925). F. S.

2086. *Band-Spectra of Crystals and Complex Gases.* **H. Kahler.** (Nat. Acad. Sci., Proc. 11. pp. 266–269, May, 1925.)—The work of Nichols on uranyl salt crystals has shown that the bands can be represented by

$$\nu = k + (a_1'n_1' - a_1''n_1'') + (a_2'n_2' - a_2''n_2'') + \ldots + (b_1'n_1'^2 - b_1''n_1''^2) + (b_2'n_2'^2 - b_2''n_2''^2).$$

Heurlinger, Kratzer, Hulthén, Runge and others have shown that in many cases the different quantum transitions have a common initial or end state. The equation then gives $\nu = k + a_1'n_1' + \ldots$, with spacing a_1' if a_1'' is put equal to a constant, or else $\nu = k - a_1''n_1'' + \ldots$, with spacing a_1'' if a_1' is put equal to a constant. The corresponding intervals for uranyl salts are 700 units and 850 units respectively. The band-spectra of benzene, investigated by Henri, and those of other gases studied by other workers are similarly discussed. F. S.

2087. *Study of Electrically-exploded Wires.* **S. Smith.** (Mt. Wilson Observat. Contrib. No. 285. Astrophys. J. 61. pp. 186–203, April, 1925.)—A grating spectrograph is described in which the spectrum is reflected from one of the faces of a rotating mirror on to a photographic film so that changes with time are recorded. The "time-resolving power" is defined in analogy with "optical-resolving power," and shown to be about one one-millionth of a second for the instrument in question. The results obtained with exploded wires of Pb, Sn, Al, Cu, Cd and Mg are described for the region λλ3000–5000 Å. For certain elements small areas on the surface of the mass of vapour produced by explosion proved to be very opaque, the effect being attributed to anomalous dispersion. A method is described for determining the relative resistances of metallic vapours, and results are given for Cu, Ag, Au, Ni, W, Zn, Al, Pb, Sn, Li and Fe. F. S.

2088. *Absorption and Emission Spectra in Mercury-Vapour.* **L. A. Turner** and **K. T. Compton.** (Phys. Rev. 25. pp. 606–612, May, 1925.)—In a quartz tube 4 cm. in diameter mercury-vapour was maintained at 3 mm. pressure and current sent from a tungsten filament to a nickel anode 18 cm. away. The absorption of light from a quartz Hg arc lamp was photographed with a small Hilger quartz spectrograph. (1) *Absorption by the Continuous Positive Column.*—Several lines of the diffuse and subordinate triplet series were absorbed by atoms in the $2p$ states, $2p-2s$ lines very strongly, $2p-3s$ lines less strongly, $2p-3d$ lines strongly, $2p-4d$ lines less strongly, $2p-5d$ lines weakly. No trace of absorption of combination lines by $2p$ atoms or of absorption by other excited atoms was observed. (2) *Absorption by the Striated Positive Column* (obtained by adding hydrogen).—The bright region of the striation showed greater absorption of the $2p-2s$ lines than did the dark regions. (3) *Emission Spectra of Various Parts of the Discharge.*—The negative glow emitted the arc spectrum and the spark line 2848. All these lines appeared with diminishing intensity through the Faraday dark space. The continuous positive column emitted the arc spectrum. The striated positive column emitted the arc spectrum and HgH bands. The intensity of emission attained its maximum for different lines at different regions in the striations in a manner apparently connected with the excitation energies for the lines. F. S.

2089. *Critical Potentials Associated with Excitation of Alkali Spark Spectra.* **F. L. Mohler.** (Bureau of Standards, Sci. Papers No. 505. pp. 167–191, 1925.)—Various forms of electron tubes are described, including a new type suitable for the spectroscopic study of discharge with very low current density. The voltage for the excitation of spark lines was determined for both low and high current densities and the spectra photographed with a Hilger quartz spectrograph, type C. The potentials Li 54, Na 35, K 19, Rb 16 and Cs 14 measure the work required to remove a single electron from the rare gas shell of the normal atom. Each of these values is equal to the ionisation potential of the neighbouring rare gas ion. The critical potential for low-current excitation gives the work required to remove two electrons by a single collision. The potentials K 23 volts and Rb 21·6 volts apparently measure the work required to remove the second electron from an ion with the valence electron removed. A table of wave-lengths is given in the case of Cs with intensities observed at five voltages. F. S.

2090. *Tesla-luminescence Spectra. Part V. Some Polynuclear Hydrocarbons.* **W. H. McVicker, J. K. Marsh** and **A. W. Stewart.** (Chem. Soc., J. 127. pp. 999–1006, May, 1925.)—In previous papers [Abstracts 278 (1924) and 116 (1925)] accounts were given of the spectra emitted under the Tesla discharge by the vapours of benzene and a number of its substitution products. In the present communication the work is extended into the field of polynuclear-benzene derivatives, and so falls into two parts: (1) The spectra of compounds containing two or more isolated benzene rings (diphenyl, diphenylmethane, triphenylmethane, dibenzyl, stilbene, tolane); and (2) the spectra of compounds containing fused rings (fluorene, acenaphthene, anthracene, etc.). A. B. W.

2091. *Arc Spectrum of Lanthanum between λ3100 I.A. and λ2200 I.A.* **S. P. de Rubies.** (Comptes Rendus, 180. pp. 1478–1481, May 18, 1925.)—This is the first of a series of proposed measurements on the arc spectra of the rare earths which are not known beyond λ3000 Å. The oxide was used, and exposures of two minutes with a current of 4–8 amps. given. The results are given in I.Å., together with intensities. F. S.

2092. *The Structure of the Cobalt Spectrum.* **M. A. Catalán** and **K. Bechert.** (Zeits. f. Physik, 32. 5. pp. 336–369, 1925.)—In agreement with Walters [Abstract 568 (1925)], the arc spectrum of cobalt is found to possess a multiple line structure. Doublets, quartets, and sextets have now been established, and the fundamental term is an *f*-term of the quartet system (confirmed by the absorption data of v. Angerer and Joos). All terms are reversed, the magnetic moment of the cobalt atom amounting to six Bohr magnetons in the fundamental state. A new form of the selection principle for the azimuthal quantum number is given. The level scheme of the spectrum shows great similarity with that of iron, and the terms are unusually regularly arranged; 517 lines have been measured, and the paper includes an enormous collection of data. H. H. Ho.

2093. *Spectrum of Silicon at Successive Stages of Ionisation.* **A. Fowler.** (Roy. Soc., Phil. Trans. 225. pp. 1–48, April 8, 1925.)—Photographs were taken with a large quartz spectrograph, a small quartz instrument, and a vacuum grating spectograph. The light sources included a carbon arc with silica and potassium fluosilicate on the poles, and an arc between pieces of fused silicon for the Si I spectrum; a spark between pieces of fused silicon for Si II; and a vacuum tube discharge in vapour of silicon chloride or tetrafluoride for Si II, Si III and Si IV. The bore of the capillary was adjusted to give the various stages of ionisation. As expected from theory, series have been traced with constants R, 4 R, 9 R and 16 R respectively for the various stages of ionisation. The spectrum of Si I includes singlets and triplets. The ionisation potential cannot be less than 7·5 volts. The spectrum of Si II includes a doublet system analogous to that of neutral aluminium. The resonance potential is 8·09 volts and the second ionisation potential 16·27 volts. The spectrum of Si III is of the same type as that of Al II or Mg I, including triplets and singlets. The probable value of the resonance potential is 4·85 volts, and of the ionisation potential 31·66 volts. The spectrum of Si IV, as shown in a previous paper [see Abstract 2176 (1923)], forms a doublet system similar to that of Al III, Mg II and Na I. The resonance and ionisation potentials are respectively 8·86 and 44·95 volts. Tables are given of wave-lengths at various stages of ionisation as well as of spectral terms and effective quantum numbers. F. S.

2094. *Wave-length and Width of K Absorption Limit of Zinc.* **B. Walter.** (Zeits. f. Physik, 32. 6. pp. 409–414, 1925.)—It was shown in a previous paper [Abstract 844 (1925)] that the characteristic K radiation of zinc is excited by the L_β line of tungsten, $\lambda = 1279{\cdot}17 \times 10^{-11}$ cm, and that the L_γ line of tantalum, $\lambda = 1281 \times 10^{-11}$ cm., is absorbed, so that the wave-length of the K-absorption limit of zinc must lie between the two wave-lengths given, *i.e.* $1280 \pm 1 \times 10^{-11}$ cm. From theoretical considerations the value $1280{\cdot}08 \times 10^{-11}$ cm. has been calculated. The width of the absorption limits of zinc was estimated by a comparison of the intensities of the two lines, mentioned above, with other lines on the same sides of the limits, and it was found to be less than 2×10^{-11} cm. F. J. B.

2095. *The Ultra-violet Absorption Bands of Oxygen. I. Their Relation to Temperature. II. A Short Wave-length Iodine Spectrum.* **C. Füchtbauer** and **E. Holm.** (Phys. Zeits. 26. pp. 345–349, May 23, 1925.)—I. Observations have been made on the absorption of ultra-violet light in oxygen at various temperatures, the source being a zinc spark and the gas at about 1 atmos. pressure being contained in a quartz tube approx. 0·60 cm. long, closed with quartz plates, the tube being heated in an oven. The absorption bands were photographed at temperatures from 400° C. to 1050° C. in the spectral region 2000–2200 Å.U., and it is shown that in every case the spectra increase greatly in intensity with rising temperature, the bands extending towards greater wave-lengths at higher temperatures. The latter observation is explained in terms of the increasing oscillation energy of the atoms with increasing temperature. Since the temperature can only influence the initial state corresponding to the absorption process, during the change from a higher quantum level to the final state at higher temperatures, less energy change is involved than at lower temperatures, and hence the frequency decreases and the band extends towards longer wave-lengths. This fact is intimately connected with changes of specific heat with temperature. The wave numbers of the bands have been examined by Kratzer, who has provisionally deduced the rotation quantum numbers of the corresponding energy levels, a table of values being given. The previously observed bands of oxygen are verified, and two new systems with limits at $\nu = 54{,}166$ and $54{,}626$ are found. The values of the quantum numbers agree with the previous explanation of the temperature effect. It is also concluded that the electronic transitions very greatly loosen the bonds between the two atoms of the molecule at high temperatures, producing large variations in the moment of inertia of the molecule. II. *Short Wave-length Line Spectrum of Iodine* [see Abstract 1654 (1925)].

—The short wave-line spectrum of iodine has been investigated under various conditions, a table of lines being given. New lines have been observed at 1876, 1844·3 and 1830·5, decreasing in intensity towards short wave-lengths. W. V. M.

2096. *Spectra of the Metals of the Aluminium Sub-Group.* **K. R. Rao.** (Phys. Soc., Proc. 37. pp. 259–264, June, 1925.)—The absorption of thallium vapour is studied from λ2400 to λ2000, and that of indium from λ6000 to λ2000. A steel absorption tube provided with quartz windows and heated in a charcoal furnace to 1500° C. was used. The spectra were photographed with a quartz spectrograph, Schumann plates being used between λ2400 and λ2000, and the continuous background was furnished by an aluminium spark under water. Tables of the wave-lengths absorbed are given. The first members of the series, $1\pi_2 - m\delta'$, were found in both cases to show a symmetrical absorption. A channelled spectrum, consisting of asymmetrical bands degraded towards the red, appears at high temperatures on the short-wave side of $1\pi_2 - 2\delta'$. F. S.

2097. *Experimental Determination of Relative Transition Probabilities in the Sodium Atom.* **G. R. Harrison.** (Phys. Rev. 25. pp. 768–782, June, 1925.)—Direct measurement of line absorption intensities was made by a precise method of photographic photometry previously described. On each plate 11 spectra were photographed, 5 absorption spectra of light from an aluminium under-water spark which had passed through 10 cm. of vapour, and 6 calibrating spectra of a constant cadmium spark. Corrections were applied for densitometer slit width, plate characteristics, band absorption, and sensitometer slit width and dispersion curve. The doublets were unresolvable at the vapour-pressures used, and were treated as single lines. Line shapes were measured at 18 different vapour densities, covering a four-fold variation, and from these were determined the constants C_1 and C_2 in Slater's formula for transition probabilities as given by his theory of virtual oscillators, $N\kappa h\lambda_0 B_{ij} = c\pi \log_e 10 \times \sqrt{C_1/C_2}$, and the relative transition probabilities B_{ij} for the various lines 2 to 16. No decrease in relative probability of the higher numbers with increasing vapour-pressure was found, the curves for $\log_{10} NB_{ij}$ as a function of term number for different pressures being practically parallel. From the smoothed curves average relative values of B_{ij} were obtained with a variation of 2 to 4 %, and from these the corresponding relative values of A_{ij} were calculated from Einstein's relation $c^3 A_{ij} = 8\pi h\nu_0^3 B_{ij}$. Hoyt's preliminary theoretical calculation of the ratio of the first two terms was found to agree closely with these results. AUTHOR.

2098. *The Nature of the Iodine Line* 2062 Å. **L. A. Turner** and **K. T. Compton.** (Phys. Rev. 25. pp. 791–794, June, 1925.)—Dissociated iodine vapour at 1100° to 1500° C. in a quartz tube failed to show any resonance fluorescence of the 2062 line in a 78-minute exposure in the same apparatus in which mercury-vapour gave a detectable fluorescence of the 2537 line in a 1-second exposure. This fact and the narrowness of the 2062 line in absorption seem to indicate that the lower level involved in the transition producing this line is not the normal state of the atom, but is a slightly higher one. A calculation based on the observed line width shows that this level is probably at least 0·545 volt above the normal level, and suggests that there may be a resonance line of atomic iodine at about 1800 Å. **Authors.**

2099. *On the Nature of the Compton-Effect; an Experimental Contribution to the Theory of Radiation.* **W. Bothe** and **H. Geiger** (Zeits. f. Physik, 32. 9. pp. 639–663, 1925. From the Reichsanstalt.)—An arrangement of experiments designed to compare the conception of the Compton-effect hitherto prevailing with that suggested by Bohr, Kramers and Slater [Abstract 2065 (1924)]. As at present conceived, a recoil electron should be perceptible simultaneously with each dispersion quantum. According to Bohr, the connection is much less rigid, and should practically disappear in these experiments. The arrangement consists essentially in registering separately by means of two pointed counters (*e*-counter and *hν*-counter) the recoil electrons and the scattered radiation of a very small volume of hydrogen and in ascertaining whether coincidences occur between the registered discharges. The experiments showed that about every eleventh *hν*-discharge was simultaneous with an *e*-discharge. This is not consistent with the Bohr conception, but may be expected, according to the older conception, if the unavoidable imperfection of the experimental conditions be taken into account. Definite detection of the coincidences was at first rendered difficult by the subsequently revealed fact that the pointed counters worked with lag varying up to 1/100 of a sec. Only when this had been practically eliminated by superimposing on the point field a more homogeneous field was it possible to achieve an accuracy of time measurement amounting in the course of the experiments to 1/10,000 of a sec. The paper gives illustrations of apparatus and tables of results. **E. F.**

2100. *Quantum Theory of the Intensity of the Modified Band in the Compton-Effect.* **G. E. M. Jauncey.** (Phys. Rev. 25. pp. 723–736, June, 1925.)—The theory of a previous paper [Abstract 1670 (1925)], which dealt with the scattering of X-ray quanta by electrons in circular Bohr orbits, is extended to the scattering by L and M electrons and by electrons in elliptic orbits. For a certain range of positions of the electron in each orbit the mass of the whole atom is added to that of the electron, and the quantum is scattered without change of wave-length. For a given type of K, L or M orbit, the ratio of the number of modified scattered quanta to that of the unmodified quanta is calculated. From this the intensity of the modified band relative to that of the unmodified line, when all the K, L and M electrons are operative in the scattering process, is determined. Curves are given showing the intensity of the modified bands when MoKα X-rays are scattered by carbon and sulphur at 30° and 90°. The theory gives for the ratio of intensity of modified band relative to unmodified, ·90 and 1·74 for carbon at 30° and 90°, and 0·42 and 0·62 for sulphur at 30° and 90°, the ratio increasing with the scattering angle and decreasing with increasing atomic number. This result tends to explain the difficulty which has been experienced in obtaining the modified band when MoKα X-rays are scattered by sulphur. **Author.**

2101. *Intensities of the Components in the Zeeman-Effect.* **L. S. Ornstein, H. C. Burger** and **W. C. van Geel.** (Zeits. f. Physik, 32. 9. pp. 681–683, 1925.)—By a generalisation of the rules which the intensity measurements of spectral lines have afforded, the prediction of the intensity relationships of the components of a magnetically resolved spectral line [see Abstract 103 (1925)] has been rendered possible. The present paper deals with the experimental determination of the intensities of the Zeeman components of the zinc triplet ($2p_i - ss$), brief experimental details being included. Good agreement between theory and experiment is recorded, with consequent confirmation of the predicted intensity relationships. A little asymmetry may perhaps be traced to the Paschen-Back effect.

H. H. Ho.

2102. *Term Problems in Doublet Spectra.* **G. Wentzel.** (Ann. d. Physik, 76. 8. pp. 803–828, June, 1925.)—A complete statement of the terms of Röntgen spectra, as well as of the alkali spectra, is obtained by consideration of an n_k path with reference to relativity and penetration of the inmost shell. Calculation in the case of X-ray and Millikan's ultra-violet spectra can be made by assuming the charge on the shell to be equal to or less than that of the nucleus. For the approximation $k^2 \ll n^2$ the law of the screening-doublet is $\Delta\sqrt{v/\mathrm{R}} = 0{\cdot}6 \times$ a whole number. All alkali and X-ray terms can thus be expressed as functions of two quantum numbers, n and k, if negative values of k be allowed. In the limiting case of the H-atoms the method leads back automatically to Sommerfeld's theory of fine structure. The paper is mathematical. F. S.

2103. *An Experimental Determination of the Energy used in Ionising Air by Means of X-Rays of Different Wave-lengths,* **L. Kriegesmann.** (Zeits. f. Physik, 32. 7. pp. 542–555, 1925. Abstract.)—An air thermometer is described which enables the energy of the X-radiation to be measured by a compensation method, by measuring the current necessary to produce the same heating effect in a resistance mounted in one bulb, as is produced by the X-rays when absorbed in a lead plate contained in another. The coefficient of absorption in air was measured by two methods for the wave-lengths investigated. The absorbed energy was compared with the ionisation produced by the same rays, and the energy of ionisation expressed in ergs and volts. A table giving the relation between the number of ions generated and the wave-length enables the ionisation measurements to be at once converted into absolute energy values. It is shown that Holthusen's assumptions as to the relation between the wave-length and the amount of energy required for equal ionisation are incorrect, while those of Boos are qualitatively confirmed. It is proved experimentally that hard rays need more energy for equal ionisation than soft ones.

H. N. A.

2104. *Note on the Scattering of X-Rays.* **P. Debye.** (Journ. Math. Phys., Mass. Inst. of Technology, 4. pp. 133–147, May, 1925.)—The phenomena observed by Laue and Bragg give us evidence of two fundamental facts: (1) The scattered X-rays must have phase relations with the primary rays; (2) the intensity of scattering depends on the inner properties of the atoms inducing scattering. There seems to be no reason why the atoms in a molecule should act in another manner than the atoms in a crystal, and hence it should be possible to detect the interference effects corresponding to the geometrical arrangement of the atoms in the molecule. Debye states that the principal maximum of the scattering function (*i.e.* the first interference ring surrounding the primary ray passed through liquids) must be due to interferences between the different molecules of the liquid. Experiments by Keesom (Journ. de Physique, 4. p. 144, 1923) led him to the same statement—especially since he was able to photograph the ring even with a monatomic gas in the liquid state—and are conclusive. The paper consists chiefly of an attempt to show that even if the molecules are comparable with hard spheres, this fact alone is sufficient to cause a scattering function, exhibiting a maximum. This maximum occurs at an angle defined by the quotient of the wave-length and the diameter of the sphere substituting the molecule. W. V. M.

2105. *On the Mechanism of X-Ray Scattering.* **A. H. Compton.** (Nat. Acad. Sci., Proc. 11. pp. 303–306, June, 1925.)—On any spreading wave theory, including that of Bohr, Kramers and Slater, which abandons the strict principles of conservation of energy and momentum, there should be no correlation between the direction of ejection of the recoil electron and that of the effect of the scattered quantum. R. D. Bennett has recently used two Geiger point counters, one to receive the recoil electron and the other to catch the scattered quantum. Each of a pair of head-phones was connected with one of the counters through a three-stage amplifier, and simultaneous impulses in the two phones were listened for; the coincidences were more frequent when the quantum counter was near the angle predicted by the quantum theory. The author, in collaboration with Simon, has made use of cloud expansion photographs, showing simultaneously a recoil electron and a secondary β-ray track produced by the scattered X-ray quantum; this method has also yielded provisional results. When stray X-rays were reduced to a relatively low intensity 350 plates were obtained, the deviations Δ of the observed tracks in which, from the theoretical angle, are plotted in a diagram; this shows that they are concentrated round zero in accordance with the quantum theory, while on the spreading wave theory they should be nearly uniformly distributed between 0° and 180°. Further experiments are in progress. Geiger and Botha have also observed the conicidences demanded by the quantum theory. H. N. A.

2106. *An Investigation of the Tungsten X-Ray Emission and Absorption Spectrum with a Vacuum Spectrometer.* **R. V. Zumstein.** (Phys. Rev. 25. pp. 747–752, June, 1925.)—Using a cast bronze X-ray tube and a vacuum spectrometer, the M series of tungsten has been studied both in emission and absorption. A new type of window for the X-ray tube was made by grinding lampblack with collodion. In the emission spectrum between 7 Å. and 5 Å. two faint lines have been observed, $\eta_1 = 6\cdot857$ and $\eta_2 = 6\cdot789$ Å. Two components of the α and β lines have been measured, $\alpha' = 6\cdot948$, $\beta' = 6\cdot720$ Å., confirming the work of Hjalmar. In the absorption spectrum five lines, $M_1 - M_5$, have been observed at 6·708, 6·475, 5·416, 4·800, 4·365 Å. The wave-length of the first two are less than their predicted values by an amount (about 2 %) which is greater than the probable limits of error (± 0·006 Å.). M_3 has a component $M_3' = 5\cdot380$ Å. M_5 is very weak. AUTHOR.

2107. *Characteristic X-Rays from Lithium.* **G. K. Rollefson.** (Phys. Rev. 25. pp. 740–746, June, 1925.)—A previously described method [Abstract 1495 (1924)] has been used to determine radiation and ionisation potentials of metallic lithium. The values obtained are 39·2, 43·07, and 46 volts as radiation potentials and 48·4 volts as the ionisation potential. In terms of energy levels these are interpreted as corresponding to the differences $1_1 \rightarrow 2_1$, $1_1 \rightarrow 2_2$, $1_1 \rightarrow 3_1$, and $1_1 \rightarrow \infty$ respectively. The radiation potential at 43·07 volts corresponds to the $K\alpha$ line of lithium. This value is used to extend the Moseley curve for the $K\alpha$ lines, and the values for the other light elements are obtained by interpolation. The wave-lengths in Ångström units given for these elements are: Li, 286·5; Be, 132·8; B, 74·4; C, 49; N, 33·2; O, 24·4; F, 18·6; Ne, 14·8.

AUTHOR.

RADIO-ACTIVITY.

2108. *Origin of Radio-activity.* **E. Briner.** (Comptes Rendus, 180. pp. 1586–1589, May 25, 1925.)—Remarks on the classical theory of atomic disintegration of radio-active elements, considered mainly from the point of view of emission of thermal energy. A. B. W.

2109. *A Method of Analysing Radio-active Radiations by Means of Absorption.* **Mme. J. S. Lattès.** (Comptes Rendus, 180. pp. 1400–1402, May 11, 1925.)—Refers to a previous paper [Abstract 1674 (1925)] and gives in tabular form the different positions given to the radiator of fixed thickness, and the analysing screens of variable thickness, with respect to the radio-active source, the poles of the electromagnet and the ionisation chamber, showing for each position the nature of the rays entering the chamber with and without the magnetic field, and making it clear how, from the different measurements, it is possible to determine separately the primary γ-radiation, the β-radiation excited by the γ-rays in the radiator, and the primary β-radiation. The total radiations of each type can then be decomposed by the usual methods, and divided into groups characterised by their coefficients of absorption, independently of the thickness traversed. This analysis shows that a definite group of secondary β-rays corresponds to each group of primary γ-rays, and that it is possible to find an equation representing the intensity of the secondary radiation. H. N. A.

2110. *The Magnetic Spectrum of High-velocity β-Rays from Radium B + C.* **J. d'Espine.** (Comptes Rendus, 180. pp. 1403–1405, May 11, 1925.)—Refers to a paper by the author, in collaboration with D. K. Yovanovitch, on β-rays with very high velocity from mesothorium II and thorium B + C. Experiments made with radium B + C confirm the existence of two rays with $H\rho = 9960$ and $H\rho = 10{,}700$, agreeing with observations by Danysz, Rutherford and Robinson, and Ellis; the results also show a band of fast rays between $H\rho = 15{,}000$ and $H\rho = 27{,}000$. This band is very weak, but has been measured on a whole series of plates obtained with different magnetic fields; the band is composed of several groups of rays, which pass very easily through thin aluminium screens placed on the photographic plate. A table gives the results obtained by the author and by other experimenters. H. N. A.

2111. *The Absorption of β-Rays by Matter.* **G. Fournier.** (Comptes Rendus, 180. pp. 1490–1492, May 18, 1925.)—In a previous paper [Abstract 1126 (1925)] the author has shown that μ/ρ is a linear function of the atomic number in the case of several elements. The coefficients of absorption of Mg, Fe, Ni, Zn and Cd have now been measured, and a table gives the observed and calculated values of μ/ρ for eleven elements with atomic numbers below 50, and shows that the law holds for all of them. For elements with higher atomic numbers the phenomenon is complicated by the secondary radiation. It is assumed that the coefficient of absorption for the primary radiation continues to obey the same law as before, and that the parasitic secondary radiation can be studied by subtracting from the total emergent radiation the calculated emergent primary radiation. Making use of a formula recently introduced by Mme. J. S. Lattès, the following values are obtained for μ'/ρ for the secondary radiation, Pt 14·7, Au 14·6, Th 14·5, Pb 14·3, μ/ρ for the primary radiation having the values 26·076, 26·218, 26·502, and 26·644 for these elements. The fact that μ'/ρ is less than μ/ρ leads to the conclusion that the secondary radiation is of electromagnetic nature; its coefficient of absorption must vary in a complex manner with the atomic number of the substance, which is radiator and absorber at the same time. H. N. A.

2112. *The Scattering of Beta-Rays.* **J. Chadwick** and **P. H. Mercier.** (Phil. Mag. 50. pp. 208–224, July, 1925.)—As compared with the scattering of α-particles, the corresponding experiments with β-particles are attended by numerous difficulties, due partly to the available sources of β-particles and partly to the small energy of the particles. The β-radiation from a radio-active source is not homogeneous, and the scintillation method is not available. The authors use a method similar to that formerly employed by Chadwick for α-particles, the particles being scattered by a thin foil in the form of an annular ring, the small source being placed on the line perpendicular to the plane of the ring and passing through its centre, the scattered particles which pass through a hole O on the same line on the other side of the ring being measured; source ring and point O are surrounded by an evacuated box. The scattered rays which concentrated at O passed through a thin aluminium window into a hemispherical ionisation chamber, so that the path through the air of the chamber was independent of their direction. The thinnest obtainable foils were used, and it was shown that the conditions for single scattering were approximately fulfilled. Aluminium, copper, silver and gold were compared. The scattering varies with the atomic number in the way demanded by the theory of single scattering. The fraction of particles scattered is slightly greater than is to be anticipated on the theory. This may be due to error in estimating the quantities concerned in the calculation of the theoretical fraction, due to the use of a heterogeneous beam of β-rays.
H. N. A.

2113. *The Long-range Particles emitted by Polonium.* **Irène Curie and N. Yamada.** (Comptes Rendus, 180. pp. 1487–1489, May 18, 1924.) —Refers to a previous paper by Yamada [Abstract 1421 (1925)], and describes new experiments in which compressed gases were used instead of solid screens in measuring the range. The results confirm those previously obtained, and in spite of all precautions in preparing the sources a small number of long-range particles were found. The number is about proportional to the quantity of polonium, and does not seem to depend on the metal which supports it. The particles do not form a homogeneous group; the number diminishes rapidly from 4 cm. to from 12 to 14 cm. equivalent range. In oxygen or in carbon dioxide the total number of these particles is about ten for 10^7 α-rays; there are more in air (about thirty for 10^7 α-rays), and their maximum range is about 16 cm. Judging from the intensity of the scintillations, it appears very improbable that these particles are α-rays. They may be H-particles projected by the α-rays. The fact that the maximum range is about four times as great as that of the α-rays supports this; but it is difficult to understand why this number should be the same with different metal supports and with O and CO_2, which probably have not the same impurities. The behaviour in air is also difficult to explain; the range does not seem to indicate the presence of nitrogen disintegration products. H. N. A.

2114. *Long-range Particles emitted by the Active Deposit of Thorium.* **N. Yamada.** (Comptes Rendus, 180. pp. 1591–1594, May 25, 1925.)—Rutherford and Wood found by a scintillation method that the active deposit of thorium emitted a group of α-particles of range 11·3 cm. in air at N.T.P. [see Abstract 1277 (1921)] in the proportion of 1·5 per 10,000 particles of 8·6 cm. range. Bates and Rogers repeated the observations, and found three groups of long-range α-particles (11·5 cm., 15 cm. and 18·4 cm.) in air at N.T.P. in the proportions of 220, 47 and 55 respectively per 10^6 α-particles of range 8·6 cm. [see Abstract 1197 (1924)]. The author has repeated the experiments by a different method, and depositing the thorium active deposit on different metal surfaces. He concludes, in agreement with Rutherford and Wood, that thorium active deposit only emits one group of long-range particles—*viz.* that of range 11·5 cm.—and suggests that the two extra groups observed by Bates and Rogers were due to hydrogen particles. The author finds, however, that the ratio of 11·5 cm. α-rays to 8·6 cm. α-rays is approximately 2·9 per 10,000. A. B. W.

2115. *Proof of the Existence of Retrograde H-Particles from Disintegrated Atoms.* **G. Kirsch.** (Phys. Zeits. 26. pp. 379–380, June 5, 1925.)—Considers the observations of Rutherford and Chadwick, in which the backward ranges of H-particles from different substances were determined, and shows that in reality these backward ranges were those of particles sent off at right angles to the directions of the colliding α-rays. Thus Rutherford and Chadwick have not proved the existence of retrograde H-particles; but this has been accomplished in Vienna by means of investigations carried out by specially devised methods (H. Pettersson, Mitt. Ra-Inst. 168 and 173). H. N. A.

2116. *The Geiger Counter.* **T. Wulf.** (Phys. Zeits. 26. pp. 382–391, June 5, 1925.)—A Leyden jar charged by a small influence machine is successfully used as a source of e.m.f., and a gramophone needle as a point in a Geiger counter. Either an electrometer or a high-resistance telephone, without an amplifier, can be used for observing the discharges produced by radium. It was found that the range of voltage producing good results depended on the fineness and the material of the points, on the sign of the charge, the gas in the counter, the gas-pressure and humidity; and these relations were investigated. Viewing the point in the dark, it was found that a brush luminosity was visible for each discharge, independently of the sign. With positively-charged points in air the highest number of discharges per second was found to be about twenty. Some considerations are brought forward bearing on the manner in which the discharges are obtained and broken off in the Geiger counter. H. N. A.

HEAT.

2117. *A Hydrogen Liquefying Cycle and Cryostat for the Maintenance of Low Temperatures.* **W. M. Latimer, R. M. Buffington** and **H. D. Hoenshel.** (Am. Chem. Soc., J. 47. pp. 1571–1576, June, 1925.)—Liquid hydrogen is used as a cooling agent, and, in order to increase the amount of liquid hydrogen produced in the liquefier, the hydrogen gas evaporating from the liquid in the cryostat is passed over the coils of the liquefier. It is necessary to purify the hydrogen carefully, otherwise the valve orifice becomes plugged up with solid oxygen and nitrogen; the amount of impurity must not exceed 0·05 %. The preparation of pure hydrogen is discussed and the feasibility of ferrous-pyrocatechol analysis for small percentages of oxygen is pointed out. Details are given of the cryostat and liquefier. H. N. A.

2118. *Corrections regarding the Subject of Specific Heats.* **S. Wiesner.** (Ann. d. Physik, 76. 8. p. 802, June, 1925.)—A note on the origin of the values taken for constants in the previously published paper [Abstract 1143 (1925)]. The value assigned to "*n*" is the specific refraction $\left(\frac{n-1}{d}\right)$, and not the specific atomic volume. The correction leads to the Lorentz-Lorenz equation for atomic refraction. The corrections are applied in practical examples, and tables given showing the tolerable agreement so obtained. S. G. B.

2119. *Latent Heat Determinations.* **A. W. Smith.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 711–722, June, 1925.)—*I. Heat of Fusion of Ice.*—The electrical method of determination gave 334·21 joules per gramme at the heat of fusion, using a Weston (unsaturated) standard cell whose e.m.f. was 1·0193 volts, compared with the standard Clark cell (e.m.f. = 1·434 at 15° C.) at the Bureau of Standards. In terms of the present value of the international volt the e.m.f. of this cell would be 1·01845 international volts. Making this change and reducing the weighing to vacuum gives the heat of fusion as 333·23 international joules per gramme mass, *i.e.* 79·63 calories, taking the mean value of the calorie equal to 4·185 international joules. With another form of calorimeter used at the Bureau of Standards, in which no liquid is required [see Abstract 81 (1916)], the mean of three determinations gave the heat of fusion equal to 333·64 international joules, or 79·72 mean calories per gramme mass. The mean of thirteen experiments carried out in a calorimeter with the water a few degrees above room-temperature [see Abstract 894 (1914)] gave the heat of fusion as 333·49 international joules, or 79·69 calories per gramme mass. In the method of mixtures, which is simple in theory and was extensively adopted in the earlier investigations, the calorimeter for the electrical method at the Bureau of Standards was used. The mean of eight determinations gave the heat of fusion as 79·61 calories (15°), or 79·59 mean calories per gramme mass, measured directly in terms of the thermal capacity of water and not involving the ratio of the joule to the calorie. In the method of cooling, which is suitable for measurements at high temperatures, two similar crucibles are employed, one containing the molten metal and the other a metal which does not change its state at the temperature used. *II. Heat of Evaporation.*—A discussion of the investigations of Regnault, Berthelot and Kahlenberg is followed by a reference to the experiments of Richards and Mathews. [See Abstract 902 (1911) and Abstract 77 (1918).] E. F.

2120. *The Kinetic Theory of Evaporation.* **D. B. Macleod.** (Faraday Soc., Trans. 20. pp. 525–543, April, 1925.)—The assumption is made that the ratio of the density D_v of the vapour above a liquid to the density D_e of the liquid is really the ratio of the number N_s of molecules with sufficient speed to escape from the liquid to the number N_i with insufficient speed—*i.e.* that $D_v/D_e = N_s/N_i$. Results from a paper by Ramsay and Shields (Roy. Soc., Phil. Trans. 184. p. 647, 1893) are made use of to test the theory. Maxwell's equation, $y = 4\pi^{-\frac{1}{2}}x^2e^{-x^2}$, expressing the probability of any given speed x of a molecule, is employed to obtain the number of molecules with speeds greater than any specified speed x. It is thus found possible to determine the value of x, corresponding to a value of D_v/D_e, which is the minimum velocity at a given temperature that a molecule must have to be able to escape from the liquid. If their final condition is a vapour, the mean kinetic energy (K.E.) of the molecules must be the same as that of the liquid molecules, being at the same temperature. The difference, therefore, between the total K.E. of 1 gramme of the escaping molecules and the total K.E. of 1 gramme of the liquid or vapour as a whole must be the latent heat of vaporisation of the liquid. The author, employing graphical methods throughout, obtains latent heats of vaporisation of several liquids, including ethyl ether, carbon tetrachloride, benzene, and ethyl acetate at temperatures up to their critical point. After increasing all the results in a certain ratio, "on account possibly of some of the energy of rotation being part of the total kinetic energy of escape," good agreement is obtained between the calculated values and those given in published tables. T. B.

2121. *Graphical Treatment of the Simple Gas Laws.* **B. Eck and E. Kayser.** (Zeits. Vereines deutsch. Ing. 69. pp. 871–875, June 27, 1925.)—The authors here describe a process for the graphical evaluation of the principal equation of state for the perfect gas, whereby the general polytropic changes of state can be considered in a simple way. A similar process is also included for ascertaining the work of a perfect gas. The paper contains several examples of particular cases, with seven illustrative diagrams. H. H. Ho.

2122. *The Temperature Dependency of the Molecular Heats of Gases, especially of Ammonia, Methane, and Hydrogen, at Low Temperatures.* **F. A. Giacomini.** (Phil. Mag. 50. pp. 146–156, July, 1925.)—Since the discovery of the extraordinarily rapid fall of C_v for hydrogen down to the value of a monatomic gas at low temperatures, attempts at its explanation (since the phenomenon seems to stand in marked opposition to the deductions of the equipartition of energy theorem), chiefly by means of the quantum theory, have been unsuccessful, mainly due to lack of data [see Abstract 1614 (1920)]. The work outlined in this paper was undertaken to supply such data concerning the relation of the energy-content of gas molecules to the temperature, particularly in that temperature-domain in which the value of the said energy-content sinks beneath that value which the molecule must have when considered as perfectly rigid and as having three degrees of freedom of rotation (decrease in the rotational energy of the molecule). The method depends on Nernst's principle concerning the determinability of the molecular heat of a gas at constant volume. The comparison-measurements of C_v are obtained by determining with a very sensitive membrane-galvanometer the pressure-rise which immediately follows upon the transmission of a small inductive electrical impulse through a diminutive constantan foil placed towards the centre of the vessel, this being an extension of Voller's method. Details are included of the apparatus and of the measurements effected, together with a study of the errors involved. The observations made on H_2 are in excellent agreement with Eucken's, and the C_v values obtained in the neighbourhood of 200° abs. are also in accord with Scheel's at 197° abs. A remarkably rapid fall of the $C_v - T$ curve for NH_3 has been found. Further papers are promised. H. H. Ho.

2123. *New Design for Apparatus to Measure the Coefficient of Deviation from Boyle's Law, and the Determination of this Coefficient for Acetylene.* **J. T. Howarth** and **F. P. Burt.** (Faraday Soc., Trans. 20. pp. 544–549; Disc., 549, April, 1925.)—The apparatus described is similar to one previously used by Whytlaw-Gray and Burt [Abstract 1568 (1910), but (1) entirely surrounded by melting ice; (2) having the upper chamber of the manometer furnished with six glass points, whose vertical distances above the "dead-space" point could be exactly determined once for all; (3) entailing the use of only about 8 c.c. of gas. Measurements of pressure-volume were made on carefully purified acetylene, an accuracy of about 1 part in 10,000 being claimed. The coefficient of deviation from Boyle's law per mm. referred to, p_0v_0, is $[d(pv)/dp] \times 1/p_0v_0$, and its value between 0 and 1 atmos. was found to be $-0 \cdot 00884$. In the *Discussion*, **F. G. Donnan** stated that only a slight correction would be needed to bring in the surface-tension effect. Iredale had been measuring this as a function of the partial pressure of certain vapours. T. B.

2124. *The Kinetic and Electromagnetic Definitions of the Thermodynamic Temperature of a Gas.* **E. Wertheimer.** (Zeits. f. Physik, 32. 8. pp. 596–619, 1925.)—When a gas is contained in an enclosure, its total energy consists of the mass energy of the gas molecules and the radiation energy within the enclosure. The thermodynamic temperature of the gas may be defined from either of these energy quantities, but the author shows that the true result is obtained only from the electromagnetic energy. The developed theory is applied to the problems of the temperature of space and of the atmosphere. G. E. A.

2125. *On a Method of Calculating the Vapour-Pressure of a Solution with a Simple Solvent and a Non-volatile Solute.* **S. B. Mali.** (Phil. Mag. 50. pp. 141–145, July, 1925.)—Stern's mechanical model for the theoretical calculation from kinetic considerations of the integration constant of the vapour-pressure formula for a substance is first described, and its resemblance pointed out to the known model of matter in the crystalline state as revealed by X-ray work. Stern's value for the integration constant actually coincides with those found by Sackur and Tetrode for monatomic vapours [see Abstract 1389 (1912)], a noteworthy result in view of the fact that certain physicists are inclined to believe that matter in the liquid state possesses an unstable crystalline structure. Stern has determined the vapour-pressure formula for simple condensed systems, and the present author now shows that with very simple modifications Stern's assumptions can be utilised to find the vapour-pressure formula for a dilute solution with a non-volatile solute, especially when the solvent is monatomic both in the liquid and vapour states. The vapour-pressure formulæ for pure solvent and solution are found to differ only in the terms containing the latent heat of evaporation, being otherwise identical. Also the constant of integration comes out as identical in both the cases—an expected result, since this constant, as explained by Nernst, depends upon the nature of the evaporating molecules and is independent of the nature of the condensed system. H. H. Ho.

2126. *The Theory of Molecular Interaction in the Liquid State.* **G. N. Antonoff.** (Phil. Mag. 50. pp. 265–289, July, 1925.)—Evidence is collected to show that the changes due to variation of temperature in the liquid state take place in a discontinuous manner. Densities, latent heats of evaporation, surface tensions and viscosities are investigated, and all show kinks in the temperature curves at the same temperatures. The densities (δ) and the latent heats of evaporation (L) vary according to a definite exponential law, which is general for both normal and associated liquids, and practically for all ranges of temperature, *viz.* $Ae^{\lambda\delta} = T + B$ and $Ce^{\mu L} = T + D$, where T is the temperature measured from the critical point. These formulæ are valid for an interval between two kinks with constants which are different for each interval. For surface tensions (α) and viscosities (η) there is also an exponential law, $\alpha + B = Ae^{\lambda T}$ and $\eta + C = De^{\mu T}$, where T occurs in the exponential. These facts are interpreted as indicating definite molecular changes in given intervals of temperature. H. N. A.

2127. *The van der Waals Equation of State and the Liquid State of Aggregation. II.* **J. Berger.** (Zeits. phys. Chem. 115. pp. 1–28, Feb., 1925.)—The author now shows that his values for *b* in the van der Waals equation are additive, except where association takes place [see Abstract 167 (1925)]. Association produces deviations with regard to heat expansion, heat of vaporisation, and in the additive properties of *b* which are parallel to one another. From experimental data on the compressibility of liquids he constructs new isothermal equations which, he suggests, represent the facts with greater accuracy. He shows that the volumes near the critical points, calculated from the data obtained for the liquids, agree much better than the older values obtained from the critical data. The theorem of corresponding states is shown much better with the author's values of *a* and *b* than with the older values. These values of *a* and *b* applied to the van der Waals equation for saturation pressure will also hold quite well in the case of slightly associated substances. W. C. S. P.

2128. *On the Principle of Mechanical Transformability (Adiabatic Hypothesis).* **M. v. Laue.** (Ann. d. Physik, 76. 6. pp. 619–628, April, 1925.)—The current proofs of the Ehrenfest principle of mechanical transformability, applied where the adiabatic invariance of the active quantities I_k cannot be guaranteed, have in general as exceptions all the cases in which between the *f* average motions ω_k any rationality relation $\sum_1^f \tau_k\omega_k = 0$ (τ_k integral) arises. From Burger's work [see Abstract 284 (1918)] on small adiabatic changes, it would seem as though the principle failed for states of degeneration. Born's investigation is briefly discussed, following which a new proof is advanced in which the majority of exceptions are shown to be non-existent and the validity of the principle established. The paper is entirely mathematical. H. H. Ho.

SOUND.

2129. *Large Forced Vibrations of Stretched Strings.* **R. N. Ghosh.** (Indian Assoc. for Cultivation of Science, Proc. 9. 2. pp. 145–154, 1925.)—A description of experiments with the longitudinal form of Melde's experiment, in which the ratios between the periods of the vibration and of the string were 2/2, 3/2, 4/2, 5/2, etc. It was found that in all these cases (1) the phase-difference between the vibrator and the string altered with changes of tension in a particular manner for a given ratio, and (2) that the amplitude of the maintained motion was small when the tension was high, increasing with diminution of tension and reaching a limiting value at a certain low tension, beyond which the motion suddenly collapsed. C. V. Raman's theory is here extended, and the formulæ modified by taking into consideration the finite amplitude of motion and adding a term βy^2 to n^2 in the equation of motion. Separate formulæ are given for the ratios 2/2, 3/2, and 4/2. They show agreement with the experimental results (1) and (2) above, and indicate further that the amplitude is determinate. E. H. B.

2130. *Electrical Method for Impact on Struck String.* **W. H. George.** (Roy. Soc., Proc. 108. pp. 284–295, June 2, 1925.)—On applying the electrical method for the study of the impact between hammer and string it was found that valuable information concerning pressure variations during an impact may be obtained by allowing the two impinging bodies to complete the circuit through an oscillograph. The existence of important pressure variations and the times at which they occur during the impact upon the struck string have been established. It has also been found that there is in some cases a momentary separation between hammer and string. These results cannot be explained on the theories of Helmholtz, Delemer, Lamb, or Bhargava-Ghosh, but may be explained later on the theories of Kaufmann, Das, or Raman-Banerji. It is found that the use of the ballistic galvanometer to determine the duration of the impact of the hammer on a string is, in general, invalid. The use of the ballistic method in the study of other types of impact where rapid tremors occur may introduce errors into the results. The interesting result predicted by Raman-Banerji, that the duration of the impact grows in a fluctuating manner as the striking place is moved away from the bridges to the midpoint, is here confirmed for a hammer of the same mass as that of the string. The paper is illustrated by seventeen photographic records and a view of the apparatus. [See Abstract 2899 (1924).] E. H. B.

2131. *Spark Photography as a Means of Measuring Rate of Explosion.* **J. E. Smith.** (Phys. Rev. 25. pp. 870–876, June, 1925.)—The explosive was placed in a long cartridge having excess charges in small equally spaced side openings set off in succession as the explosive reached them, so that each became the centre of a spherical sound wave. An instantaneous photograph of the shadows of these sound waves was obtained by means of a spark when the explosion reached a certain opening and closed an electrical circuit. Rates of explosion for various charges were found as follows: Lead styphnate, 0·11 × 0·15 × 10 cm., 369 metres per sec.; loosely packed mercury fulminate, 0·15 × 0·25 × 14 cm., 1025 metres per sec.; well-packed gunpowder, 0·45 cm. in diameter and 12 cm. in length, 261 metres per sec. AUTHOR.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2132. *On the Electric Capacity of Certain Solids of Revolution.* **D. M. Wrinch.** (Phil. Mag. 50. pp. 60–70, July, 1925.)—An expression for the capacity of solids whose generating curves are certain closed nodeless epicyclics of retrograde type, ranging from the circle to the three-cusped hypocycloid, is derived, and an approximate expression is given which is correct to at least 1 in 64. H. N. A.

2133. *Electrical Charges at a Liquid-gas Interface.* **H. W. Gilbert** and **P. E. Shaw.** (Phys. Soc., Proc. 37. pp. 195–213; Disc., 213–214, June, 1925.)—This paper is a general review and discussion of the various methods of studying the potential differences and electric charges which arise at a liquid-gas interface. The authors divide the subject into the following main headings: (*a*) The determination of the p.d. at the surface liquid-gas when one or both of these is at rest. (*b*) Cataphoresis of gas bubbles. (*c*) Passage of gas over a liquid without rupture of the latter, or of a gas over a wet solid with the same proviso. (*d*) The fall of a liquid in an unbroken column through a gas. (*e*) Liquid jets. (*f*) Waterfall electricity. (*g*) Electrification produced by bubbling gases through liquids. (*h*) Electrification produced by shattering drops in air-stream. (*i*) Electrification produced by spraying a liquid. An attempt is made to coordinate the material obtained from this vast area of research. Many of the results may be obtained in terms of the modern theory of orientation and polarisation of the liquid-gas interface, but there are other facts which do not appear to come within the scope of established principles. Suggestions are made as to possible developments in future research. F. S. B.

DISCHARGE AND OSCILLATIONS.

2134. *Rotating Carbon Arc.* **Pauthenier.** (Comptes Rendus, 180. pp. 1834–1836, June 15, 1925.)—An arc has been described by Garbarini in which current passes from a positive carbon pole to a copper ring, the arc being caused to rotate by a magnetic field towards the ring produced by a solenoid in the arc circuit. This type of arc will not work on direct current if a carbon ring be substituted for the copper. Rotation is produced, however, if alternating current be used. It is slow (one or two per sec.) for 500 ∼, and very rapid, but unstable, for 50 ∼. F. S.

2135. *Initial Discharge Voltage and Breakdown Field Intensity for Parallel Cylindrical Electrodes.* **H. Löber.** (Archiv f. Elektrot. 14. pp. 511–528, May 25, 1925.)—The high-potential voltmeter described by Klemm [Abstract 1552 (1924)] was re-designed and improved in certain respects. Measurements of the breakdown field intensity for parallel plates in air were made for distances of 0·1 to 1 cm., and results were obtained about 0·5 % less than those obtained by Klemm. The initial discharge voltage between two equal parallel cylinders and between an earthed plane and a parallel cylinder was determined for distances from 0·1 to 17 mm. For cylinders of diameter 3 to 7 mm. silver steel rods were used, and for diameters 7·82 to 12 mm. brass rods were employed. The results are presented in a series of tables and diagrams, and are compared with the theoretical results obtained by Schumann [Abstract 1553 (1924)]. A. W.

2136. *Electron Reflection in Gases: Researches on Hydrogen.* **H. Baerwald.** (Ann. d. Physik, 76. 8. pp. 829–848, June, 1925.)—The apparatus used and the general experimental method employed is described. The following points are then dealt with: The amount of reflection; the integral and differential velocity distribution curves; the pressure and tension variations of P- and R-curves; the comparison of the P- and R-curves. It is found that the reflection in hydrogen is connected with loss of energy. When 11 volts is exceeded this loss is more clearly marked. When 16 volts is exceeded positive electricity is demonstrable. The question of ionisation is also considered. A. E. G.

2137. *Electrical Properties of Neon, Hydrogen and Nitrogen.* **S. P. McCallum** and **C. M. Focken.** (Phil. Mag. 49. pp. 1309–1320, June, 1925.)—This paper describes further investigations, with the same apparatus as employed by J. S. Townsend and S. P. McCallum [see Abstract 1886 (1924)], on neon, hydrogen and nitrogen. The authors find that the rate of increase of ionisation with increase in electric force is very much greater in neon than in the diatomic gases, hydrogen and nitrogen. Further, in neon, as in helium, there is a very small change in the rate of increase of ionisation with electric force for large changes of pressure—*e.g.* from 2 mm. to 20 mm.—whereas in the diatomic gases increases from 1 mm. to 4 mm. in hydrogen and from 0·5 mm. to 2 mm. in nitrogen produce large changes in the electrical conductivity. This is the result to be expected if the electrons lose large amounts of energy in collisions which do not produce ionisation, which is in accordance with the results of other experiments made in the same laboratory on the loss of energy of electrons in collision with the molecules of gases. The authors suggest that the additional ionisation which becomes appreciable for higher values of the electric force appears to be due to positive ions becoming more active with increasing velocity, or to radiation excited by collisions of electrons with much higher velocities than required to ionise the gas molecules. The experiments show that this action is much larger in monatomic than in diatomic gases. G. W. DE T.

2138. *Motion of Electrons between Coaxial Cylinders under the Influence of Current along the Axis.* **A. W. Hull.** (Phys. Rev. 25. pp. 645–670, May, 1925.)—The current from a large electrically-heated filament to a coaxial cylindrical anode limited by the circular magnetic field is first considered under the following heads: (1) *Motion of the Electrons.*—The equation for the critical plate voltage is here derived in a simpler and more general form, which holds for any degree of space charge. Electrons leaving the filament are deflected in the direction of the electron current in the wire, and describe paths which are found, by approximate integration of the equations of motion, to be somewhat elongated cycloids. The dimensions of the paths are calculated for typical cases. The conclusion that the circular and axial magnetic fields act independently is fully verified experimentally. (2) *Plate Current as a Function of Voltage.*—Results for tubes with tungsten filaments 0·75 mm. and 2·5 mm. in diameter are given. The reflection effect is directly proved with a special tube, which enables the current to various sections of the anode to be measured independently. (3) *Plate Current as a Function of Filament Current.*—If the voltage is kept constant at a high enough value, and the filament current slowly increased, emission begins at a certain temperature and increases rapidly (temperature limited), and then decreases sharply to zero (magnetically limited). With an alternating filament current the plate current is suppressed, except during the part of each cycle when the instantaneous filament current is below the critical maximum. Finally, there are experiments with Pring tube containing filament and metal disk. The explanation offered by Langmuir in 1913, that the decrease of electron emission with improvement in vacuum observed by Pring and Parker was due to charge on the glass walls, is verified. A. E. G.

2139. *Diffusion of Slow Electrons in Electric Fields.* **G. Hertz.** (Zeits. f. Physik, 32. 4. pp. 298–306, 1925.)—The diffusion of electrons in a noble gas under the influence of an electric field is calculated, and it is shown that the motion of electrons in an electric field must in every case be treated as a diffusion problem. In particular, it cannot be stated without question that the mean velocity with which an electron travels in an electric field in a gas is determined by the field strength, the velocity of the electrons, and its mean-free path ; it is much more in great measure dependent upon the form and size of the space in which the diffusion takes place. A. E. G.

2140. *Experimental Method of Research on Occurrences in Lamps with Glowing Kathode.* **A. Katsch.** (Zeits. f. Physik, 32. 4. pp. 287–297, 1925.)—A relatively simple means is given for ascertaining experimentally the influence of the mechanical arrangement of the electrodes upon the paths of electrons in a highly evacuated tube with glowing kathode. A luminous discharge at very low pressures (10^{-4} to 10^{-5} mm. Hg) is used as indicator of the motion of the electrons. This method is employed in a simple example. A. E. G.

2141. *Passage of Electricity through Vacuum Tubes.* **R. Whiddington.** (Engineering, 120. pp. 20–21, July 3, 1925. Lectures delivered at the Royal Inst.)—A general account of the three lectures in which both familiar and novel vacuum discharge phenomena were demonstrated. A photograph obtained as the result of an experiment here described shows that the striations travel from the anode to the kathode at a definite velocity. The inclination of these striations to the mirror axis shows in this instance that the velocities range from 10^4 to 10^6 cm. per sec. Striations seem to be possible under certain conditions of pressure and current and only in impure gases, and to require a strong negative field at the head of a striation. A. Güntherschulze has suggested that the striations are due to electrons from the kathode moving at low speeds, such that their collisions with gas molecules are practically elastic, the energy losses involved very small, and negative ionisation and recombination almost negligible. It is here suggested that the rush of electrons up to the anode would, at some distance from it, produce a layer of positive ions which temporarily shield the anode; the positive emission ceases for a moment, and the positive ions are driven away with a definite speed from the anode by the potential applied; but new electrons arrive at this sheet of positive space charge and keep up by ionisation the supply of positive ions therein. The process is then repeated, each "flash" of positive ions pushing out its predecessor by electrostatic propulsion.

A. E. G.

2142. *Standing Electric Waves on Parallel Wires.* **W. S. Huxford.** (Phys. Rev. 25. pp. 686–695, May, 1925.)—Oscillations of wave-length from 1 to 10 m. were obtained by means of a valve generator. Analysis of the possible free modes of vibration of the parallel wire receiving system employed indicates that for normal coupling with the generator two sets of current maxima are always to be found. The sliding bridge used to determine the current maxima consisted of a thermojunction which was connected to a sensitive galvanometer. It was found that a change in the terminal conditions at either end of the parallel wires changed the position of the set of resonance points formed by reflection of waves from that end, but did not alter the positions of the resonance points due to reflection from the other end. The half-wave-length is equal to the distance between successive maxima in each of the two sets. Measurements were obtained constant to 1 part in 1000. The measured wave-length was found to be independent of mutual effects of exciter and receiver, and was not altered by a change in the diameter or spacing of the receiving wires or by change of the material, provided it is non-magnetic. A. W.

2143. *Potential Waves along Conductors.* **W. Rogowski** and **E. Flegler.** (Archiv f. Elektrot, 14. 5. pp. 529–530, May 25, 1925. Corrected reprint given in No. 6, July 7, 1925.)—Oscillograms are given of the waves obtained on a pair of conductors 75 m. long when a potential of 1000 volts was suddenly applied to one end. A battery of accumulators was used, bridged by a condenser of capacity about 1 microfarad. The oscillograph was of the kathode-ray type, and a description of this will be given in a subsequent paper. The oscillograms are of the rectangular type predicted theoretically by Kirchhoff in 1857, but exhibit secondary oscillations of much smaller amplitude, which may possibly have been due to the fact that the conductors (copper tubes 1 cm. in diameter, with walls 1 mm. thick) were bent twice at right angles to accommodate them in the room where the experiments were carried out. A. W.

2144. *The Propagation of Short Waves.* **M. Lardry.** (Comptes Rendus, 180. pp. 1584–1586, May 25, 1925.)—A record of observations made at Mans in 1924 of short-wave reception on three different wave-lengths, employing the shunted telephone method. Reception from l'École supérieure des P.T.T. (450 m.) gave rise to marked scintillations (variations in received intensity), the amplitude varying from 100 to 1000 in 15 sec. or less, the variations in general being smaller by day than by night. During the spring the reception is more feeble during the day, but a reversal of this rule occurs in July. Scintillations are similarly noticed in the reception from the Eiffel Tower (115 m.), but they are much more rapid; the wave-length also varies continuously. Observations are made on three different stations working on about 50 m., scintillations being again pronounced, the reception from one station during the first three months of the year being very feeble during the day and zero by night. The audibility at times varies from 2000 to 50 in three minutes.

E. T. A. R.

2145. *Theory of Valve Generators for Very Short Waves.* **J. Sahánek.** (Phys. Zeits. 26. pp. 368–376, June 5, 1925.)—A comprehensive theoretical treatment of the generation of very short waves by means of valves leads to the conclusion that, with the simple valve circuit considered, valves with cylindrical electrodes can be used provided the ratio of the radii of the anode and grid lies within the limits $2 < \rho_A/\rho_G < 5$, where ρ_A and ρ_G are the respective radii of the anode and grid. The condition under which a falling characteristic can be obtained is given and an expression obtained for the energy of the oscillations. The effect of eccentricity of grid and filament with respect to the anode is also considered, and oscillations are shown to be possible if the eccentricity of the grid and anode does not exceed a certain limit. The eccentricity of the filament has little or no effect. Experiments carried out with various valves confirmed these conclusions. [See Abstract 1471 (1925).] A. W.

2146. *Device for Demonstrating Short Electromagnetic Waves.* **R. M. Fisher.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 675–678, June, 1925.)—Describes apparatus for demonstrating the fundamental properties of electromagnetic waves. A transmitter has as its antenna two metal arms, each ending in a blunt conical spark-gap electrode of brass. Sparking is produced by connecting the secondary of a spark coil to the gap. Coupled to the receiving antenna is a small rectangular loop of wire, having in series a crystal detector and condenser (1 mf.), across which is connected a d'Arsonval galvanometer. The apparatus may be used to demonstrate tuning, opacity of conductors and wire screens, interference and standing waves, reflection, etc., the optimum wave-length for all purposes being 1 metre. E. T. A. R.

2147. *The Resonance of Coupled Circuits.* **L. Ollat.** (Comptes Rendus, 180. pp. 1725–1728, June 8, 1925.)—The author has verified experimentally the theoretical relations between the frequencies of the two coupling waves in two circuits tuned and coupled together and having the same damping. The square of the damping is neglected as compared with the square of the frequency, which is allowable for the high-frequency circuits with small resistance used in radio-telegraphy. The resonance curves of each of the coupling oscillations were traced, using a Gutton Laville ideostatic electrometer. This method has the advantage, as compared with the thermoelectric one, of not introducing any additional resistance into the circuit. The method employed when the resonance curve has a very sharp peak is described. Two circuits coupled as strongly as possible were first tested, the coupling coefficient measured with the wave-meter having the very high value 0·957; the lengths of the two coupling waves were found to be 1108 and 160 metres; the free wave-length of each of the coupled circuits was 810 metres; the calculated values were 1125 and 167 metres, the agreement being as good as can be expected. The damping for each of the two waves agrees fairly well with the theoretical value. Measurements with smaller coupling coefficients also gave results which agreed with the theory. H. N. A.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2148. *The Effect of a Magnetic Field on the Electrical Resistance of Liquid Metals and Alloys.* **E. J. Williams.** (Phil. Mag. 50. pp. 27–46, July, 1925.)—Attributes the change in the resistance of a liquid conductor in a magnetic field to a true resistance change and a change depending on the energy used up in hydrodynamic currents set up in the liquid; an expression for this energy is obtained by means of dimensional analysis. In bismuth amalgams it appears that the increase of resistance in a 1 % bismuth amalgam is 0·00010 % in a field of 4000 gauss; in molten bismuth the estimated true change at 420° is of the order of 0·002 % in a field of 3000 gauss; in other cases the hydrodynamic effect predominates, and in most cases the true change is negligible. In some cases δr varies with the current, and this is explained by supposing the motion of the liquid to be turbulent; this turbulence is confirmed by the experimental work of T. J. Jones [see next Abstract]. H. N. A.

2149. *The Electrical Resistance of Mercury in Magnetic Fields.* **T. J. Jones.** (Phil. Mag. 50. pp. 46–60, July, 1925.)—The experiments show that, for fields of from 2000 to 10,000 gauss, the resistance change in a straight column of Hg of about 0·5 cm. diameter, with 5 to 0·5 amps., δR is proportional to $H^{1\cdot 58}d/i^{0\cdot 40}b^{0\cdot 41}$, where H, d, i and b are field, diameter of column, current and distance between magnet poles. The change of resistance increases with the rise in the temperature of the mercury. With wide tubes and comparatively large fields and currents, the effect in Hg is mainly, if not entirely, of a different nature from that exhibited by solid metals. The magneto-resistance changes are independent of the resistance of the column of mercury in the field. This effect and the results obtained with thick copper leads, which filled the tube, and with platinum-wire leads, seem to indicate that the resistance changes are probably due to some effects occurring in the Hg at the places where the current enters or leaves it; or, if the leads are outside the field, in those portions of the mercury column near the edges of the poles. The results are considered in the light of the theory of E. J. Williams [see preceding Abstract]. The mercury is set in motion at the places where the magnetic field is not uniform or where the current density in the field is not constant. This motion was demonstrated by placing one of the current leads so as just to enter the free surface of the column in the magnetic field, a vigorous motion being observed. The theory explains all the observed phenomena. H. N. A.

2150. *Penetration of Solid Insulators.* **L. Inge, N. Semenoff, A. Walther.** (Zeits. f. Physik, 32. 4. pp. 273–286, 1925.)—The heat theory of the penetration of insulators put forward by Wagner, and further developed by Rogowski and Karman, leads to a definite dependence of tension of penetration on the temperature and thickness of the insulator, which is expressed by the formula $V_m^2 = (33\cdot 5k\rho/b)e^{-f(a)}$, when the resistance of the insulators alters according to the equation $\rho = \rho_0 e^{-bT}$, where k and ρ are the conductivity of heat and the electric conductivity of the insulators at the temperature at which penetration takes place, and $e^{-f(a)}$ is a correction factor depending on the thickness and conductivity of heat of the insulators, etc. This formula is proved by experiments for rock-salt at temperatures of 450° to 700°. The whole course of penetration tension in dependence on temperature is considered, and it is shown that the heat theory in its pure form can scarcely explain the penetration at low temperatures. It is suggested that a combined ionisation-heat theory might be used. **N. Semenoff** (*ibid.*, 32. 11-12. p. 948, 1925). A. E. G.

2151. *Dielectric Absorption and Power Losses: a Contact Theory.* **L. Hartshorn.** (Phys. Soc., Proc. 37. pp. 215–232; Disc., 232, June, 1925.)—Absorption, residual charge, and allied phenomena in solid dielectrics. The dielectric is assumed to possess a certain true capacity, defined by its dielectric constant, and a certain conductance, here considered as probably electrolytic in type. The so-called anomalous properties are considered to be due to the properties of the contact surfaces of the dielectric and its metal electrodes. These contact surfaces appear to offer great resistance to the passage of ions or electrons across them, so that when an e.m.f. is applied to a condenser there is an accumulation of charges at the surfaces. These charges constitute the absorbed and residual charges. The experimental evidence in support of this hypothesis is reviewed. The behaviour of each contact surface is such that it may be represented by a large capacity in parallel with a high resistance, and thus a capacity-resistance combination is suggested, which is equivalent to an actual condenser. The properties of this combination are considered mathematically with reference to the experimental laws of absorption and power losses in alternating fields, and the extent to which the theory is capable of explaining the experimental results is pointed out. The bearing of the theory on dielectric measurements under various conditions is also discussed. A. D.

2152. *Constancy of Total Photo-current from Sodium with Temperature Change 20° to − 190°.* **R. C. Burt.** (Phil. Mag. 49. pp. 1168–1176, June, 1925.)—When an evacuated electric bulb of soda-glass is immersed stem upwards in molten sodium nitrate and a p.d. of 100 volts established between the lighted filament and the salt, sodium passes from the salt anode through the glass electrolyte and evaporates inside the bulb and condenses on the latter above the heating liquid. To obtain a sufficiently perfect vacuum to keep the sodium surface clean, the bulb is best attached to a mercury pump. Measurements of the total photo-current of the sodium show that this current is constant, within a few per cent., over a temperature range extending from 20° to 190°, provided that the surface of the metal is sufficiently pure. If the surface is just slightly contaminated, it may be much more sensitive at low temperatures than at room-temperature, and if somewhat more contaminated by an unknown vapour the surface may be several times less sensitive at liquid-air temperature than at room-temperature. T. H. P.

2153. *Low-voltage Electron-beam Oscillograph.* **J. W. Buchta.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 581–590, May, 1925.) —The author has designed a special form of electron gun with which he is able to get a well-defined electron beam with a driving voltage of the order of 30, provided the tube is filled with mercury-vapour at a pressure corresponding to the ordinary room-temperature. The beam itself is luminous; no special fluorescent screen is necessary for the observation of the spot. The following are stated to be the main requirements for the production of a good low-voltage beam : (1) A well-shielded space, so that space charges do not prevent its formation ; (2) presence of mercury-vapour for production of positive ions ; (3) a high electron emission ; and (4) a small and fairly well-enclosed space between the hot kathode and anode to prevent an arc forming. F. S. B.

2154. *Calibration of a Thermojunction Galvanometer System.* **Abadie.** (Onde Élec. 4. pp. 133–148, April, 1925.)—Results obtained during the calibration of these systems with iron-constantan couples are given and discussed. The results obtained with direct currents are compared with those obtained with very low-frequency and with musical-frequency currents. A. E. C.

2155. *Two Modifications of the Simple Drum Type Potentiometer and a Design for a Double Potentiometer.* **A. G. Worthing** and **W. E. Forsythe.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 599–604, May, 1925.)—(1) Diagrams are given showing how a Leeds and Northrup K potentiometer may be converted into a limited double potentiometer. In this modification the shift from a voltage to a current setting is made by merely throwing a special switch. (2) In measuring pyrometer currents for the disappearing filament pyrometer an ordinary ammeter is not sufficiently sensitive for some work ; at the same time the standard potentiometer is too slow in operation for regular use. An arrangement is described which gives the quick response needed in measuring the pyrometer currents and retains the accuracy and ease of the standard potentiometer without dial adjustment for the control of the background current. (3) It is shown how the modification of the Leeds and Northrup potentiometer described in Section I can be easily adapted to a double potentiometer. A. A. D.

ALTERNATING CURRENTS AND MAGNETISM.

2156. *William Sturgeon and the Centenary of the Electromagnet.* **J. A. Fleming.** (Roy. Soc. Arts, J. 73. pp. 690–707 ; Disc., 708–710, June 19, 1925.)

2157. *The Theory of Magnetism.* **C. G. Darwin.** (Engineering, 119. pp. 693–694, June 5, 1925. Paper read before the Royal Inst., May, 1925.)—An account is given of the work of Gerlach and Stern on the determination of the magnetic moments of the atoms of vaporised metals. The significance of the results from a quantum standpoint is discussed. They seem to show that the old assumption of arbitrary atomic orientation is untenable. Similarly the work of Glaser upon the magnetism of gases supports the idea of the quantum conception as far as orientation of atomic axes is concerned. It is pointed out, however, that these experiments on the magnetic properties of gases do not fit in entirely with the general scheme, and might lead to surprising developments. A. A. D.

2158. *Artificial Magnetic Anisotropy in Nickel Wire.* **R. Forrer.** (Comptes Rendus, 180. pp. 1394–1397, May 11, 1925.)—Additional examples are given [see Abstract 1978 (1925)] of the effect of twisting a nickel wire on its hysteresis cycle. The two discontinuities found give rise to the supposition that nickel exists in two states with different coercive fields. By certain modifications of the treatment, either discontinuity may be made to disappear. Flexure alone, as when the wire is wound round a thin cylinder, produces an almost rectangular cycle, which increases in area with diminution of the diameter of the cylinder. The limiting coercive field is about 9 gauss. The same treatment when applied to stretched nickel wire causes the discontinuities to appear. G. E. A.

2159. *The Magnetism of Ferronickels* (*Thermomagnetic Properties*). **M. Peschard.** (Comptes Rendus, 180. pp. 1475–1478, May 18, 1925.)—General conclusions drawn from a study of thirty alloys of iron and nickel: (1) Ferronickels containing more than 34·4 % Ni are perfectly reversible; (2) alloys containing less than 34·4 % Ni are irreversible. The composition Ni = 34·4 corresponds to the compound Fe_2Ni. Alloys between Ni = 0 and Ni = 2·5 are perfectly reversible, whatever their previous treatment. An equilibrium diagram is constructed. W. V. M.

2160. *Magnetisation of the Ferronickels.* **M. Peschard.** (Comptes Rendus, 180. pp. 1836–1838, June 15, 1925.)—Curves are given of the magnetisation of ferronickel alloys at temperatures of 16° C, – 79° C. and – 188° C. The value of each saturation is extrapolated to absolute zero by the relation $\sigma = \sigma_0 - KT^2$. This approximation holds for a number of alloys, but not for Fe_2Ni. The curve of atomic moments expressed in magnetons shows singular points for the compounds Fe_2Ni, Fe_3Ni_2 and $FeNi_2$. F. S.

2161. *Contribution to Quantum Theory of Paramagnetism.* **I. Tamm.** (Zeits. f. Physik, 32. 8. pp. 582–595, 1925. Paper read before the Russian Physikertag, Sept., 1924.)—By means of the Langevin, Pauli and Sommerfeld theories a formula is obtained for the apparent magnetic moment of the atom. The values calculated by the formula are compared with those found from the experiments of Weiss and Gerlach, and satisfactory agreement is obtained except for Fe^{++} and Ni^{++}. It is considered that the normal condition of the atoms is multiquantic, and that the ions Fe^{++} and Co^{++} exist in a triple-quantic state. The disturbing effect of interatomic fields is discussed, and the dependence of the number of magnetons on the concentration, in the case of a dissolved salt, is indicated. [See also Abstract 995 (1924).] G. E. A.

2162. *Relations between Sunspots, Terrestrial Magnetism and Atmospheric Electricity.* **C. Chree.** (Nature, 115. pp. 982–985, June 27, 1925.)—In the case of terrestrial magnetism, a linear sunspot relation seems fairly established for the regular diurnal variation of declination (D), horizontal force (H), and vertical force (V). The correlation is by means of Wolf's formula $R = a + bS$, where R is the diurnal range of the magnetic element and S is the sunspot frequency. The relation between sunspots and magnetic storms is much less definite than that between sunspots and the regular diurnal inequality. The problem of the 27-day interval is discussed, but no definite conclusion is advanced. Similarly with regard to the relation between sunspots and atmospheric potential gradients, the question is still held to be open, thus controverting the views advanced by Bauer, who states that a definite relation exists. A. A. D.

2163. *The Lunar Diurnal Magnetic Variation at Greenwich and other Observatories.* **S. Chapman.** (Roy. Soc., Phil. Trans. 225. pp. 49–91, April 17, 1925.)—A large number of observations of magnetic elements from several observatories have been tabulated and from them the solar diurnal variation eliminated. There is left over a purely semi-diurnal phenomenon, traceable to lunar causes. Spherical harmonic analysis shows that the magnetic field causing this variation is mainly produced above the earth, though there is a part of internal origin, which, however, appears to be a secondary effect. The intensity of the field varies with lunar distance almost exactly in the same ratio as the moon's tide-producing force. The field appears to vary but little throughout the sunspot cycle. The simplest explanation appears to be that the field is a consequence of the tide produced in the atmosphere by the moon. The convective motion of the air associated with this tide, in conjunction with the earth's permanent field, gives rise to electromotive forces throughout the atmosphere. Near the ground the resistance of the air is so high that no appreciable currents result, but at higher levels the conductivity is such that appreciable currents flow and give rise to a magnetic field superimposed upon the permanent field. The secondary effect mentioned above appears to be due to induced currents produced by this lunar atmospheric current in the conducting part of the earth. This lunar variation is more marked during the daylight hours, which may be readily explained by the increased conductivity of the air caused by exposure to solar radiation. A. A. D.

2164. *Permanent Magnets : Their Theory and Practice—Some Hiatus in Metallurgical Knowledge—Difficulties in Manufacture explained.* **S. Evershed.** (Inst. El. Eng., J. 63. pp. 725–810; Disc., 810–821, Aug., 1925. Electrician, 94. pp. 394–395 and 400, April 3, 1925. Abstract.)—A general survey of some problems in connection with permanent magnets. The structure of simple carbon steels and the general efficacy of simple and complex carbides in raising the potency or coercive force of iron are discussed with reference to the allotropy of iron. The alpha iron will not dissolve the carbides appreciably, and hence the use of heat treatment in order to effect the solution, though the arrangement resulting after the subsequent cooling is unstable. The " spoiling " of tungsten steels by heat treatment is mentioned and an explanation given in terms of the decomposition of carbide molecules. This " spoiling " occurs at temperatures between 750° C. and 1214° C., above this temperature recombination and consequent restoration of the magnetic properties taking place. Some cases of decrease in " potency " with time after hardening are described and mention made of a seasonal change, most marked in cobalt steels, but also to be found in tungsten steel, in one example an oscillation in the decay curve having a period of twelve months. Practical considerations of price and efficiency of tungsten and other steels are given, a tungsten steel being regarded as having no rival for the manufacture of permanent magnets, the best steel having 0·6 to 0·7 % of carbon and 6 % tungsten. Chrome steels suffer from deficiency in inherent magnetism, are more easily spoilt and cannot be restored, and hence at present less suitable as well as more expensive. A promising line of development is the production of cast-steel magnets. The paper concludes with a discussion of artificial " ageing " and speculations on the possibility of the ferromagnetism of other materials. W. V. M.

2165. *A Null-reading Astatic Magnetometer.* **R. M. Bozorth.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 591–598, May, 1925.)—This instrument is specially applicable to the testing of small samples in the form of fine wires. An example is given relating to a wire of diameter 0·011 cm. and weighing 3 mg. The arrangement consists of two parallel magnets of equal moment and opposite direction placed horizontally 4 cm. apart and suspended by a fine tungsten wire. The specimen is placed in its magnetising solenoid so that both of its induced poles produce upon the suspended magnetic system equal torques in the same sense about the axis of suspension. The torque due to the specimen is balanced by that due to a current in a coil of suitable dimensions and position so that the method is a null one. The magnetising solenoids are 8 cm. long and are placed with axes vertical on opposite sides of the needle system. In one solenoid is placed the sample and in the other the balancing coil. Full details are given of the methods for calculating the constants of the apparatus and of the most suitable positions of the coils for mitigating the errors which enter. The sensitivity of the instrument is such that the deflection of the spot of light at a scale distance of 1 metre is 1 mm. for a change in $4\pi I$ of about 25 gauss, when the sample has a cross-sectional area of 10^{-4} cm.^{2}. A. A. D.

2166. *A Magnetic Bridge for Testing Straight Specimens and an Analysis of the Hysteresis Loop of Cobalt-Chrome Steel.* **E. Hughes.** (Phys. Soc., Proc. 37. pp. 233–245; Disc., 245–248, June, 1925.)—The author employs a permeameter resembling that of Iliovici, in which the currents in two coils providing the m.m.f. of a magnetic circuit containing the specimen are adjusted until no magnetic potential difference exists between a selected pair of fixed points on the specimen. In the present apparatus the required absence of magnetic potential difference is tested by bringing up a yoke till its ends abut upon the two points in question; the approach of the yoke should excite no current in a search-coil wound on the specimen and connected in a low-resistance galvanometer circuit. Resistance is then added to the galvanometer, and the deflection caused by a reversal of the two magnetising currents enables the flux density to be calculated. The hysteresis loss per c.c. per cycle in cobalt-chrome steel is found by this method to be approximately $0 \cdot 056\, B_{\text{max.}}^{1 \cdot 7}$ ergs, though the index of $B_{\text{max.}}$ actually decreases with increasing values of the flux density. The magnetisation curve for this substance, above the point of inflexion near the origin, is found to be given by $\frac{H - c}{\beta} = d + \frac{H}{\beta_s}$, where $\beta = B - H$, β_s is the saturation value of β, and c, d are constants. To form a permanent magnet whose external energy per c.c. is within 5 %. of the maximum obtainable, a magnetizing force of upwards of 1000 c.g.s. units must be applied to cobalt-chrome steel. The βH loop between the $+\beta$ and $-H$ axes is given by a formula similar to that for the magnetisation curve, with different constants instead of c, d, β_s, the value corresponding to β_s being much less than the true saturation density.

AUTHOR.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2167. *Surface Abrasion as a Potential Cause of Localised Corrosion.* **U. R. Evans.** (Inst. of Metals, J. 33. pp. 27–43; Disc., 44–48, 1925. Engineering, 119. p. 34, March 20, 1925. Abstract.)—These experiments were carried out to find whether the electric currents set up by local abrasion of the surface layers on metals is capable of causing serious localised corrosion. Where the corrosion product is a thin, highly protective film the abrased place will be the anode, and the current set up might be expected to concentrate corrosion upon it. It appears, however, that in order to produce corrosion in such cases not only must the film be broken away at separate points, but the metal underneath must also be eroded. It is found that for several metals (lead, zinc and copper) only a small current is produced when oxidised and unoxidised samples are immersed in sodium chloride solution. Scraping of the metallic surfaces did not appreciably increase the corrosion. The attack of hydrochloric acid on zinc is increased in the early stages by grinding away the natural surface with emery, but in the latter stages it is decreased by wiping away the black scum which forms on the surface, the reason being that this scum provides a material from which hydrogen bubbles are evolved readily. Amalgamation restrains corrosion by increasing the over-potential.

A. A. D.

2168. *Solubility of Sulphur Dioxide in Water and in Aqueous Solutions of Potassium Chloride and Sodium Sulphate.* **J. C. Hudson.** (Chem. Soc., J. 127. pp. 1332–1347, June, 1925.)—The results are given of measurements of solubility of sulphur dioxide in (1) water between 10° and 90°; (2) aqueous potassium chloride solutions containing up to 30 grms. of the salt per 100 grms. of water, also between 10° and 90°; and (3) aqueous sodium sulphate solutions containing up to 20 grms. of the salt per 100 grms. of water, between 20° and 50°. The numbers of grms. of the gas soluble in 100 grms. of water when the partial pressure of the gas is 760 mm. of mercury are 15·39, 12·73, 10·64, 8·98, 7·56, 5·54, 4·14 and 3·25 respectively at 10°, 15°, 20°, 25°, 30°, 40°, 50° and 60°. At 25° and at 35° the solubility of the gas in a solution containing y grms. of potassium chloride per 100 grms. of water is expressed accurately by the formula $S = S_0 + ay$; at 10° and 15°, however, there appears to be slight divergence from this linear relationship. In the case of sodium sulphate solutions, the solubility-salt concentration curves exhibit distinct maxima at 30°, 40°, and 50°, and probably at 20°. The two main factors determining the solubility of sulphur dioxide in salt solutions are probably the hydration of the salt and the tendency of the salt and gas to combine.

T. H. P.

2169. *Solubility Relations of Isomeric Organic Compounds. I. Introduction.* **J. Johnston.** (J. Phys. Chem. 29. pp. 882–888, July, 1925.)—The general outline of work to be undertaken with a view to a clearer knowledge of the factors which favour the formation of ortho-, meta- and para- isomers is discussed. Methods of analysing mixtures of o., m., and p. isomers are considered. A complete ternary solubility diagram can be constructed from a small number of observations when the o., m., and p. form ideal solutions, and such an equilibrium diagram may be used to readily analyse any mixtures of three pure o., m., p. components.

F. J. B.

2170. *Use of Scattered Light in the Determination of the Distribution of Size of Particles in Emulsions.* **A. J. Stamm** and **T. Svedberg.** (Am. Chem. Soc., J. 47. pp. 1582–1596, June, 1925.)—A method of determination of the distribution of the size of particles, using scattered light, has been developed. In the cases studied—potassium, sodium and cæsium palmitate and palmitic acid in benzene—the scattering of light varies as the surface or square of the radius of the particles indicates that true reflection is taking place. It has been shown the ratio of the average sizes of the particles in dispersed systems, whose diameters are at least two or three times the wave-length of light, may be determined directly from the ratio of the slopes of the intensity-concentration curves. Mass distribution curves have been obtained which agree very well with those calculated from microscopical measurements.

Different alkali soaps do not shift the mass maxima, although microscopical measurements moderate an increase in the number of small particles in going from sodium to potassium and cæsium soaps. An increase in the benzene concentrations, with the amount of stabiliser constant, causes an exponential increase in the radius corresponding to the mass maxima. An increase in benzene concentration, with the ratio of benzene to stabilise constant, gives maxima corresponding to a larger size of particles. [See Abstract 1237 (1925).] F. J. B.

2171. *A New Method of Quantitative Analysis by X-Rays.* **E. Delauney.** (Comptes Rendus, 180. pp. 1658–1661, June 2, 1925.)—The method depends upon the use of various substances as selective filters for X-rays and the measurement of the absorption of the filtered rays by the substance (in solution) to be analysed. A formula is given from which, with a simple salt, the amount present is determined by one measurement. With more than one substance (metallic salt) present, further determinations with different selections of rays—one for each unknown—are necessary. Examples are quoted giving results obtained with mixtures of $BrCl_2$, and $SrCl_2$, KCl and KBr, KBr and KI. A. B. C. L.

2172. *Changes in Röntgenograms of Celluloses during Swelling in Aqueous Solutions.* **J. R. Katz** and **H. Mark.** (Zeits. phys. Chem. 115. pp. 385–404, April, 1925.)—A Röntgenographical examination is made of cellulose fibres during swelling in solutions of sodium hydroxide, zinc chloride, calcium rhodanate, mercury potassium iodide, and cuprammonium solutions. In concentrated solutions the increase in diameter leads to a doubling of the thickness of the fibre compared with an increase of about 23 % for water alone. It is found that in solutions with over 10 % sodium hydroxide the cellulose diagram disappears and the diagram of a new substance appears whose crystallites lie parallel to the fibre axis. After washing out the alkaline solution, partial restoration of the original diagram occurs, and gives the typical appearance of mercerised cotton. Similar changes are produced with potassium hydroxide solutions in concentrations exceeding 20 %, and with lithium hydroxide in concentrations above 6 %. More prolonged exposure to these solutions leads to a profound chemical breakdown of the cellulose when the crystallites are changed into amorphous miscellæ, and the diagram disappears altogether. It is attempted to explain the results observed by the transformation of the cellulose into another chemical compound, which is decomposed by water into a substance similar, but not identical, with the original cellulose. During swelling of the cellulose in solutions of the above salts which were employed no alteration of the space lattice occurs, thereby denoting that with these the swelling is intermicellar. [See also Abstract 951 (1925).] J. N. P.

2173. *X-Ray Analysis of the Solid Solutions of Potassium Chloride and Potassium Bromide.* **T. Sasahara.** (Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No. 24. pp. 277–286, May, 1925. In English.)—From the measurements taken with different concentrations of the solid solution, prepared by fusion of the component salts, it appears very probable that the side of the unit cell changes proportionally to the molecular percentage, *i.e.* there is an additive relation between the spacing and the molecular concentration; thus the unit cell may be regarded as contracting or expanding as the new component is added, the original structure of the lattice of the pure substance being retained throughout the range of miscibility. Observations of density support this conclusion. The shrinkage of the lattice as Cl is substituted for Br may be due to a strong shrinkage effect produced by a Cl atom on the surrounding layer of atoms of the other kind, the change of lattice constant being greatest about the substituted atom and becoming gradually less as the distance increases. On the other hand, the effect may reach only the immediately surrounding atoms, and there must then be a sudden change of lattice between this group and that outside it. This would give a spectrum with two different series of lines, due to two different lattices, which is contrary to the observations. The author favours the former view, and takes it for granted that the measured constant is the mean of the series of very slightly different spacings existing in the solid solution. H. N. A.

2174. *Development of Colloidal Chemistry.* **W. D. Bancroft.** (Frank. Inst., J. 199. pp. 727–760, June, 1925.)—A useful summary of the subject, particular reference being made to bubbles, drops, grains, filaments, and films in their technical applications. T. H. P.

2175. *Soaps and the Theory of Colloids.* **J. W. McBain.** (Nature, 115. pp. 805–807, May 23, 1925. Discourse delivered at the Royal Inst., March, 1925.)—The more carefully colloids, particularly soaps, are studied, the less colloidal are they found to be. Soap illustrates nearly all the behaviour observed with other colloidal systems, and is one of the few common reversible colloids with a definite, simple, known chemical formula. In dilute solution soaps are ordinary crystalloids and dissociate into sodium and potassium ions and simple fatty ions. Concentration of the solution causes aggregation of the undissociated soap molecules to large particles (neutral micellæ) of neutral soap. Further, the fatty ions unite in small groups to form particles of a new type, the ionic micellæ, in which there is one free charge for each fatty ion. Under suitable conditions all soaps can occur in each of several crystalline forms, and in two varieties of liquid crystals or anisotropic liquids, and in some cases the solutions previously described may set to form true transparent elastic jellies. The anisotropic forms occurring in higher concentrations are not miscible with the isotropic solutions or jellies, but constitute separate phases. These doubly-refracting liquids are not elastic, but plastic, as they do not quiver when shaken, and small portions do not flow under the influence of gravity. When an ordinary soap solution sets to a true transparent jelly, such properties as conductivity and osmotic effects remain unchanged, the same equilibria and the same particles evidently existing in each. At least two crystalline forms of soap exist—namely, lamellar crystals and curd fibres—both of these giving X-ray diagrams. Under some conditions twice as much soap is required for a given amount of detergent action if the soap solution is allowed to stand for a day before use. The substance accumulating in the surface of soap solutions and of soap films is not free fatty acid, but an acid sodium soap. T. H. P.

2176. *Theory of the Dispersoid* (*Colloid*) *State.* **P. P. v. Weimarn.** (Kyoto Coll. Sci., Mem. 7. pp. 409–422, March, 1925. In English.)—The paper is a general exposition of the author's views on the colloidal state. The paper is not suitable for abstracting. F. J. B.

2177. *X-Ray Analysis of Electrolytic Brass.* **H. Nakamura.** (Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No. 25. pp. 287–292, May, 1925. In English.)—The lattice constant of electrolytic α-brass, containing 82·48 % Cu, has been determined by the powder method, and was found to be practically the same ($3 \cdot 62 \times 10^{-8}$ cm.) as in the case of cast brass of practically the same composition (82·85 % Cu); thus a solid solution is formed by the electrolytic process just as it is by the casting process. There is a slight variation of the lattice constant after annealing, the values being $a = 3 \cdot 63 \times 10^{-8}$ cm. for annealed electrolytic brass and $a = 3 \cdot 61 \times 10^{-8}$ cm. for annealed cast brass; this may be due to some difference in the homogeneity of the specimens. H. N. A.

2178. *X-Ray Analysis of Copper-Zinc, Silver-Zinc, and Gold-Zinc Alloys.* **A. Westgren** and **G. Phragmén.** (Phil. Mag. 50. pp. 311–341, July, 1925.)—The difference between a chemical compound and a solid solution is first considered. The distinction is of great importance in alloy work owing to the controversies which have arisen relating to the nature and constitution of intermetallic compounds. The present writers state that in an ideal chemical compound structurally equivalent atoms are chemically identical, whereas in an ideal solid solution all atoms are structurally equivalent. Of these two extreme types of structure the first occurs comparatively seldom in metallic phases, while the second is met with frequently. There appear to be cases in which true intermetallic compounds occur, but their nature is obscured by the fact that the constituent metals, as a rule, are soluble in the compound formed. The copper-zinc and silver-zinc systems are almost identical, each containing five different types of structure. The gold-zinc system contains the same five phases with the addition of a further two phases. Arranged according to rising zinc content the structures common to the three systems are: α, face-centred cubic; β, cubic of the Cs-Cl type; γ, cubic with 52 atoms in the elementary cube; ϵ, close-packed hexagonal with an axial ratio of 1·55–1·60; and η, close-packed hexagonal with an axial ratio of 1·80–1·90. A gold-zinc phase (ν_1) containing about 50 % of zinc was found to be cubic with an elementary cube of 32 atoms; another phase (ν_{11}), obtained by quenching gold-zinc alloys containing 53 to 54 % of zinc, seemed also to be cubic with about 90 atoms to the elementary cube. In accordance with the definitions made the α-, η-, and possibly also the ϵ-phases represent ideal solid solutions. The other phases may be regarded as solid solutions in chemical compounds, and some suggested formulæ for these compounds are given. A. A. D.

2179. *Electrical Measurements on Metals of Great Purity.* **W. Geiss** and **J. A. M. v. Liempt.** (Zeits. f. Metallkunde, 17. pp. 194–197, June, 1925.)—The specific resistance and temperature coefficient of resistance of a metal form useful means of determining the degree of purity of the latter. Small quantities of mechanical impurities, or, in general, impurities which remain in the crystallite, have little or no effect on the electrical properties, but impurities which form mixed crystals enter into the space lattice of the metal and produce changes in the electrical properties depending upon the form of the lattice and the degree of affinity between the metal and the impurities. Matthiesen's law, that the product of specific resistance and temperature coefficient is constant, always holds for small percentages of impurity, and, in the case of the tungsten-molybdenum system, it holds for the complete range of compositions. When comparing the purity of samples by aid of this relation, it is generally advisable to measure the temperature coefficients, these being affected only by impurities in the space lattice. Determinations of the specific resistance and temperature coefficient of tungsten, molybdenum, and nickel are discussed in the original. Investigations on single crystal bars of tungsten of hexagonal and rectangular section and on wire drawn from such crystals and recrystallised show the same values of resistance and temperature coefficient in the three cases, within the limits of experimental error. Thus the electrical conductivity of regular metals is not a vectorial property. The authors obtained a single crystal of molybdenum with a temperature coefficient of 473×10^{-5}, compared with from 430 to 440×10^{-5} for molybdenum as made for glow-lamps. The preparation of very pure nickel offers considerable difficulties, but, by a method described in the original, the authors obtained a sample, the temperature coefficient of which was 706×10^{-5}. R. E. N.

2180. *The Theory of Reaction Rate.* **G. N. Lewis** and **D. F. Smith.** (Am. Chem. Soc., J. 47. pp. 1508–1520, June, 1925.)—The paper discusses the theory that the rate of a given chemical reaction depends upon the concentration of activated molecules. Activated molecules are sharply defined as all of the molecules possessing more than a minimum energy, and this minimum energy is defined as the heat of activation. According to an equation of Arrhenius, $d\ln w/dT = q/RT^2$, where w is the fraction of active molecules, the number being small, and q the heat required to convert the inactive into the active form. With the above definitions it is shown that an equation of this type is exactly true in certain simple cases, and is in all cases an approximation which becomes more nearly exact the higher the heat of activation and the lower the temperature. It is shown that both collisions and radiant energy offer opportunities for the activation of molecules far greater than the number required to account for observed reaction rates. An hypothesis is advanced concerning the radius of action of a light quantum, and this leads to a simple equation for the number of encounters between molecules and the quanta of light which possess sufficient energy to activate these molecules. It is shown that no sound objection has been raised to the general radiation theory of activation, but that the special theory, which assumes activation by nearly monochromatic light, must be abandoned. J. N. P.

2181. *The Mechanism of Chemical Reaction.* **R. C. Tolman.** (Am. Chem. Soc., J. 47. pp. 1524–1553, June, 1925.)—By considering a large amount of data available on the velocity of different gaseous reactions of first and second order, it is concluded that activation may occur to some extent by all the following mechanisms which have been proposed at different times: Collision with another molecule of high kinetic energy or with one which is itself in an activated state, resulting in a transfer of energy of activation; absorption of monochromatic radiation of the frequency calculated from the temperature coefficient of the reaction rate (simple radiation theory of chemical reaction); interaction with more than one frequency (elaborated radiation theory of chemical reaction). It is shown in a number of individual cases that none of the above mechanisms alone will account for the measured relation between rate of reaction, concentration, energy of activation and temperature. In instances where the condition of activation corresponds to a weakening of the forces holding the atoms together in the molecule, the evidence available supports the view that there exists a series of activated states of nearly the same energy content rather than a single activated state. The mechanism for typical unimolecular and bimolecular reactions is held to be provided by an elaborated radiation theory which includes these assumptions of intermediate and activated states. In the light of recent developments of the quantum theory, the tautomeric activated states may be identified with higher quantum states of the molecule. J. N. P.

2182. *Photo-activation of Chlorine.* **W. Taylor.** (Phil. Mag. 49. pp. 1165–1168, June, 1925.)—Results are given of an investigation of the relation of the activation of chlorine by light and the frequency of the illumination, the photo-synthesis of hydrogen chloride being used as the criterion of the activation of the chlorine and a modified form of Burgess and Chapman's actinometer employed to determine the reaction velocity for different parts of the spectrum. The activating region of the spectrum is found to correspond with that of the general absorption of chlorine itself—that is, with the continuous band extending from about 4900 Ångström units at normal temperature and pressure, and not with the Ribaud fine structure bands. In this case, therefore, activation would seem to be concomitant with the non-quantification of the vibratory motions. T. H. P.

2183. *Affinity.* **T. de Donder.** (Comptes Rendus, 180. pp. 1334–1337, May 4, 1925.)—This paper contains an application of the Clausius non-compensated heat theorem, $dA = TdS - dQ \geq 0$, where Q is the heat received by the system during the transformation considered, T the abs. temp., S the entropy, and A the non-compensated heat or affinity. dA is never negative, and if t, the time, be an independent variable, $A \equiv A(t)$ will be an increasing or constant function for each transformation considered. The investigation is limited to the irreversible transformation of a one-phase system undergoing chemical reaction, and the generalisations of the theorems of van't Hoff and le Chatelier are obtained based on the theorem that the specific affinity (defined in the paper) is a function of the state of the system and not dependent on any transformation effected. H. H. Ho.

2184. *Contraction Constants and Affinity of Solid Compounds.* **A. Balandin.** (Zeits. phys. Chem. 116. pp. 123–134, May, 1925.)—For a series of 76 compounds, comprising chlorides of uni-, bi- and ter-valent elements, as well as bromides, iodides, fluorides, hydroxides and sulphates, the relationship between the contraction constant, $C = \frac{V}{\Sigma V_0}$, and the heat of formation (U) is, with few exceptions, expressible by a linear equation, $C = R - \frac{U}{U_0}$. The possibility of a connection between this expression and the oscillations of the solid salts is discussed. T. H. P.

2185. *On the Equilibrium State of a Mixed Salt Solution.* **N. Sasaki.** (Kyoto Coll. Sci., Mem. 7. 6. pp. 361–368, March, 1925. In German.)—This paper is a mathematical investigation of the equilibrium state of a mixed salt solution containing two monovalent anions and several kations of different valency—*e.g.* a solution of ferric chloride, sodium bromide, sodium chloride and hydrochloric acid, in which the concentrations of all possible ions and ionic groups are calculated according to a statistical method. H. H. Ho.

2186. *The Production of Ozone by Silent Discharges at Low Pressures.* **E. Warburg** and **W. Rump.** (Zeits. f. Physik, 32. 4. pp. 245–251, 1925.)—The ozonisation of oxygen per coulomb of electricity discharged in Siemens' tubes decreases slowly at first, and then quickly as the pressure diminishes. For pressures smaller than 200 mm. of mercury it is proportional to the pressure. The creation of ozone in atmospheric air is greater than the rate corresponding to the partial pressure due to the oxygen contained therein. The paper is an experimental verification of the above conclusions. S. G. B.

2187. *The Theory of the Chemical Action in Siemens' Tubes.* **E. Warburg.** (Zeits. f. Physik, 32. 4. pp. 252–261, 1925.)—The paper is a theoretical treatment in extension of a theory already put forward by the same author that in vacuum tubes the conducted current in the discharge can be separated from the total current. With diminishing potential the quantity of ozone formed per coulomb of the conductor current only diminishes very little, whilst the quantity of ozone per coulomb of total current—particularly for low potentials—diminishes considerably. A comparison is effected of the theory and the experimental results of S. Sachs [Abstract 102 (1916)]. The assumption is made that the anions are electrons, and thus 6 to 9 % of all the electronic impulses will cause ozonisation. The chemical action of the impulses of the kations, of which the number and the potential is much smaller than for electrons, can be regarded as negligible. S. G. B.

2188. *The Leclanché Cell and its Suitability for Pocket-Lamp Batteries.* **M. Gruhl.** (Zeits. Elektrochem. 31. pp. 214–249, May, 1925.)—The covering of the electrode, the carbon rod, and the position of the negative pole have only a small influence on the value of the cell, which depends largely upon the characteristics of the graphite and manganese dioxide used. The nature of the impurities present in these is most important—*e.g.* oxide of iron—while greater fineness of division gives improved results. Grinding in a colloid mill is unsatisfactory, however. The most satisfactory proportion is $MnO_2 : C :: 5 : 1$, with thorough mixing and high pressure used to fill the cell. Variations from the theoretical e.m.f. may be traced to the effect of the impurities present. B. W. C.

2189. *The Electrical Conductivity of Potassium Iodide in Bromine-Iodine Solutions.* **W. Plotnikoff.** (Zeits. phys. Chem. 116. pp. 111–118, May, 1925.)—The solubility of potassium iodide in bromine is very much increased by the addition of iodine, with 40 % iodine more than 65 % potassium iodide being dissolved at 25° C. Although the dielectric constant of bromine is small, the potassium iodide solutions possess a considerable conductivity. The specific conductivity of a 5 % solution of potassium iodide in bromine-iodine (36·9 % iodine) is 0·028 compared with a value of 0·034 in water. The results are explained by the formation of polyiodides of the type $[KnI_2]I'$, which is in accordance with the evidence supplied by Röntgenographical examination. It is considered that in bromine solutions further complexes of the type $[KnI_2 . mBr_2]I'$ may be formed, and the high conductivity is attributed to the establishment of electrical resonance whereby the vibration period of the solvent molecules corresponds with that of the intramolecular ions which constitute the dissolved complexes. J. N. P.

2190. *Thermodynamical Potential Differences at the Boundary of Two Liquid Phases.* **S. Wosnessensky.** (Zeits. phys. Chem. 115. pp. 405–423, April, 1925.)—The partition of an electrolyte between two liquid phases may be expressed by the relation $\frac{C_1}{C_2^n} = K$, where n is unity in only a few instances. If n is not unity, the e.m.f. of the cell may be calculated by the Nernst formula, if it is assumed that the partition of both ions follows the same relationship; if n is 1, the e.m.f. is zero. Experiments with sulphocyanides, acetates and chlorides show that the e.m.f. of chemical cells depends on the partition coefficient. B. W. C.

2191. *The Formation of Mixed Electrodes at Phase Boundaries.* **K. Horovitz.** (Zeits. phys. Chem. 115. pp. 424–432, April, 1925.)—Experiments with glass electrodes show that glass must be regarded as a solid electrolyte, and by the evolution of ions a mixed solid phase is formed which exhibits the characteristics of an electrode in relation to the solution surrounding it. The same glass may behave as a sodium electrode in contact with an alkaline or neutral solution of a sodium salt, as a hydrogen electrode in acid solution or a silver electrode in a neutral solution of a silver salt. The conclusions drawn by P. Gross and O. Halpern (Zeits. phys. Chem. 115. p. 54, 1925) with regard to mixed electrodes are discussed, and in the view of the author are erroneous. B. W. C.

2192. *The Dissociation of Weak Electrolytes in Water-Alcohol Solutions.* **L. Michaelis** and **M. Mizutani.** (Zeits. phys. Chem. 116. pp. 135–159, May, 1925.)—A determination is made of the influence of varying amounts of alcohol in admixture with water on the dissociation constants of a number of weak acids and bases. The pK values are derived by measuring with a hydrogen electrode and potentiometer the pH values of very dilute mixtures of equivalent amounts of the free acid and its sodium salt. Of the compounds measured, the degree of dissociation falls with increasing proportion of alcohol in the solvent. The largest effect is observed with benzoic acid, the pK value of which changes from 4·2 in a solution with 2 % alcohol to 7 in one with 90 % alcohol. The basicity constant of ammonia also falls with increasing alcohol content, though to a smaller degree, the pK value changing over the range from 0 to 90 % alcohol from 9·5 to 8·9. With phenolphthalein the acidity constant changes over this range from a pK value of 8·6 to 12·6. The deviation of measured from thermodynamic dissociation constants on account of variations in activity coefficients and boundary potentials is considered. In the case of the amphoteric amino-acids it is found that the acid and basic constants are, with any compound, displaced to a different degree by the presence of alcohol. J. N. P.

2193. *Chemistry at Interfaces.* **W. Hardy.** (Chem. Soc., J. 127. pp. 1207–1227, June, 1925.)—A useful *résumé* of the subject from both the physical and the biological standpoints. T. H. P.

2194. *Electrokinetic Relations between Sediments and Solutions of Electrolytes in Contact with Them.* **R. Labes.** (Zeits. phys. Chem. 116. pp. 1–64, May, 1925.)—Independent of Stern [Abstract 723 (1925)], but on similar lines, the author shows that the thermodynamic Nernst potential difference between two phases, liquid or solid, $\epsilon = \phi(\mathrm{I}) - \phi(\mathrm{II})$, must be distinguished from the electrokinetic potential difference $\zeta = \phi(\mathrm{I}) - \phi(h)$, from which it may differ even as to sign. The $\phi(h)$ is the potential at the boundary between the freely moving solution and the liquid film of thickness h adhering to the particle. The relation deduced is $\zeta = \epsilon \,.\, 1/e^{\beta h}$. When the solution of an electrolyte is in contact with a sediment or precipitate, ϵ will be altered when the electrolyte contains the same ions or also other ions capable of forming compounds with the ions of the sediment. The effect on ϵ will be the stronger the smaller the solution product (the product of the solution tensions of the ions) of the respective compound. The experiments were made with barium sulphate, lead chromate, zinc oxalate and silver chloride and various electrolytes. It was found that the original precipitates always retained a small kinetic charge depending upon the mode of their preparation; when an excess of kation had been used in the process, the precipitate remained electropositive even after prolonged washing. Hence the precipitates were positive or negative to start with, and most electrolytes were not sufficiently strong to reverse that charge. The charge on negative barium sulphate could not be reversed by the alkali metal kations, which proved generally weak in this respect; positive barium sulphate was not reversed by the anions of the halogens, nitrites, nitrates and iodates. The effects observed would dispense with the necessity of assuming the action of adsorptive forces. H. B.

2195. *The Electronegative Potential Series in Liquid Ammonia.* **F. W. Bergstrom.** (Am. Chem. Soc., J. 47. pp. 1503–1507, June, 1925.)—The electronegative replacement series has been determined with a number of metals and other elements, which form anions in combination with sodium or potassium. The procedure consists in allowing the salt, such as K_4Pb_9, to react with a second element, and observing if replacement occurs. As equilibria occasionally exist between adjacent elements in the series, the order of replacement is in some cases reversed by a change in concentration. In some instances the element either dissolves in liquid ammonia at the moment of its liberation or forms heteroatomic anions of the type Cl_2I'. In general, an element will displace any element to the left of it in the following series from solution containing that element as anion: Pb, Bi (?), Sn, Sb, As, P (?), Te, Se, S, I. The positions of Bi and P are somewhat uncertain. A parallelism is in some instances noted between the rates of chemical reactions, in which the reacting element enters as anion, and the order of the electronegative potential series. J. N. P.

2196. *Physical Significance of the Tension of Electrolytic Solution.* **J. Heyrovský.** (Comptes Rendus, 180. pp. 1655–1658, June 2, 1925.)—A theoretical study developing further the relationships established in a previous paper. [See Abstract 1269 (1925).] A. B. C. L.

2197. *Statistics of Surface Charges in Solutions of Inorganic Electrolytes.* **W. Wessel.** (Ann. d. Physik, 77. 1. pp. 21–42, June, 1925.)—The theory is developed according to which the ions in the interior of a solution are, through hydration, surrounded by a mobile envelope of water molecules of a thickness of several molecular radii which are grouped in accordance with their bipolar nature. On reaching the surface a partial dehydration of the ions occurs, since the complete water envelope can now only occur on the solution side of the ion. Large ions are more easily dehydrated and brought to the surface than smaller ones. Surfaces of solutions assume in consequence the charge of the larger ion. The expenditure of work involved in this partial dehydration and the potential arising are considered as a function of the distance x from the surface. The equilibrium between inorganic ions in liquid surfaces is investigated statistically. A formula for the surface potential charge is deduced in terms mainly of the difference in the ionic volumes. Concordant results are given when the formula is applied to measurements made at different concentrations with solutions of the halogen acids and halides of the alkali metals. J. N. P.

2198. *Potential of the Alkali Metals measured by the Decomposition Voltages of the Alkali Chlorides, Bromides and Iodides.* **B. Neumann** and **H. Richter.** (Zeits. Elektrochem. 31. pp. 287–296, June, 1925.)—Earlier measurements of the potential of the alkali metals gave inaccurate results in the case of fused electrolytes.

A method of obtaining the potential of the alkali metals from measurements of the decomposition potentials of the alkali hydrates at different temperatures was developed [see Abstract 1310 (1916)]. The earlier measurements were repeated and checked and the potentials of cæsium and rubidium were measured. Every precaution was taken to avoid errors due to the formation of sub-salts by the interaction of the metal and the fused electrolyte. The good agreement between the values obtained for one and the same metal with different salts and salt mixtures rendered it unlikely that any sub-salt formation had taken place. The results show that the temperature coefficient of the decomposition potentials of sodium, potassium, rubidium and cæsium is practically the same, but that of lithium differs considerably from that of the other metals. The potential of the alkali metals, extrapolated to 18° C.: Cæsium, 2·909 V.; rubidium, 2.744 V.; potassium, 2.614 V.; sodium, 2·454 V.; lithium, 2·091 V. Temperature coefficient: Na, K, Cs, Rb, $1·501 \times 10^{-3}$; Li, $1·355 \times 10^{-3}$. F. J. B.

2199. *Potential of the Metals of the Alkaline Earth Group and of the Rare Earth Metals. Determined by Measurements of the Decomposition Potentials of the Fused Chlorides, Bromides and Iodides.* **B. Neumann** and **H. Richter.** (Zeits. Elektrochem. 31. pp. 296–304, June, 1925.)—By methods of investigation similar to those used in the determination of the decomposition potentials of the alkali metals the potentials of beryllium, magnesium, calcium, strontium, barium, thorium, cerium, lanthanium, neodymium, praseodymium, and aluminium were determined. It was found that the temperature coefficient is constant for each group of metals, except in the case of beryllium and aluminium, which show considerable deviation from the other metals. The values of the potentials for the alkaline earth metals at 18° C. are: Beryllium, $0·811 \pm 0·003$ V.; magnesium, $1·422 \pm 0·001$ V.; calcium, $1·903 \pm 0·002$ V.; strontium, $2·075 \pm 0·002$ V.; barium, $2·154 \pm 0·005$ V. The temperature coefficient was: Beryllium, $0·965 \times 10^{-3}$ and the remaining elements of the group $0·714 \times 10^{-3}$. The rare earth metals gave the following values: Cerium, $2·097 \pm 0$ V.; thorium, $1·747 \pm 0$ V.; lanthanium, $1·748 \pm 0·002$ V.; neodymium, $1·645 \pm 0$ V.; praseodymium, $1·436 \pm 0·002$ V.; aluminium, $0·845 \pm 0·006$ V. The temperature coefficient was: Aluminium, $1·132 \times 10^{-3}$, and the constant value $1·870 \times 10^{-3}$ for the remaining metals of the series.

F. J. B.

2200. *Concentration and Polarisation at the Kathode during Electrolysis of Solutions of Copper Salts.* **W. L. Miller.** (Frank. Inst., J. 199. pp. 773–783, June, 1925.)—The concentrations at the electrodes during electrolysis were calculated by the diffusion theory of Weber, using the equations developed by Rosebrugh and Lash Miller. The periods of time required to liberate hydrogen from acid solutions of copper sulphate or of copper chlorides in a large number of electrolyses with constant, interrupted, successive, and sinusoidal currents are in complete agreement with the predictions of the equations. Adopting the concentrations given by these equations as basis for computing the concentration-voltages, the kathodic overvoltages during the electrolysis of acid solutions of copper sulphate have been determined by the oscillograph. There is definite evidence of the absence of any transfer resistance. The overvoltage may be expressed by the equation: overvoltage $= A + (B - 0·03) \log z_0/z$, z_0 being the copper concentration in the body of the electrolyte and z that at the kathode. B is found to be independent of the concentration of the copper, acid, and current density, and A is independent of the copper concentration, but increases with increase of acidity. F. J. B.